Appendix A

Updated Air Quality Assessment

Air Quality Assessment for STP McKay Thermal Project Project Update

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1.0 INTRODUCTION

1.1 Project Overview

Southern Pacific Resource Corp. (STP) is progressing with development of their McKay oil sands leases located northwest of Fort McMurray Alberta (Figure 1.1). STP currently holds Environmental Protection and Enhancement Act (EPEA) Approval 00255245-00-01 for the STP McKay Thermal Project – Phase 1, which is designed to produce up to approximately 12,000 bpd of bitumen. In 2011 STP submitted an Environmental Impact Assessment (EIA) and application for approval of the STP McKay Thermal Project – Phase 2 which was designed to produce up to 24,000 bpd of bitumen. This would bring total design capacity of the STP McKay Thermal Project up to 36,000 bpd.

Since submission of the EIA and application in 2011, STP has made design changes to both Phase 1 and Phase 2 of the STP McKay Thermal Project. STP is now proposing to expand production capacity of the Phase 1 CPF to 16,920 bpd and decrease the proposed production capacity of the Phase 2 CPF to 18,000 bpd. Under this revised design total production of the STP McKay Thermal Project would be 34,920 bpd.

Millennium EMS Solutions Ltd. (MEMS) has undertaken additional emissions and dispersion modelling in order to determine the potential impacts to air quality resulting from the design changes. This updated air quality assessment focuses solely on the STP McKay Thermal Project – Phase 1 and Phase 2 (the Project) emissions.

1.2 Project Refinements

The Project refinements relevant to the air quality assessment since the submission of the 2011 EIA include:

- addition of one co-generation unit to the Phase 1 facility;
- addition of two once through steam generators (OTSGs) to the Phase 1 facility;
- removal of one co-generation unit from the Phase 2 facility;
- removal of two steam boilers from the Phase 2 facility;
- addition of one glycol heater to the Phase 2 facility; and
- addition of one utility boiler to the Phase 2 facility.

Changes to building and stack configuration are also included, as a result of the changes to the central processing facilities.

1.3 Ambient Air Quality Objectives

The Alberta Ambient Air Quality Objectives (AAAQO) for the criteria air contaminants emitted by the Project are presented in Table 1.1. The objectives refer to averaging periods ranging from one hour to one year.

Table 1.1 Alberta Ambient Air Quality Objectives and Canada Wide Standards

Parameter	Period	Alberta Objectives[(a)] [μg/m³]	Canada Wide Standards[(b)] [μg/m³]
SO_2	30-day	30	–
	Annual	20	–
	24-hour	125	–
	1-hour	450	–
NO_2	Annual	45	–
	1-hour	300	–
CO	8-hour	6,000	–
	1-hour	15,000	–
$PM_{2.5}$	24-hour	30	30[(c)]
	1-hour	80[(d)]	-–

(a) ESRD (2011).
(b) CCME (2000).
(c) 98th percentile.
(d) Alberta Ambient Air Quality Guideline (AAAQG).
– No air quality standard or guideline for this averaging period/parameter.

1.4 Relationship between NO_x and NO_2

An ambient ratio approach, as described below, was used to estimate nitrogen dioxide (NO_2) concentrations from NO_X emissions.

The ambient ratio method uses simultaneously observed NO_2 and NO_X values at monitoring sites in the region and is the preferred United States Environmental Protection Agency (U.S. EPA) approach. Direction from the U.S. EPA (Wilson, 1997) indicates that the ozone limiting method (OLM) is intended for application in the plume of a single source rather than in multiple source situations.

The ambient ratio method requires that monitoring locations are representative of the areas in which the model is applied. Observed NO_X concentrations from four air quality monitoring stations (Fort McKay, Patricia McInnes, Athabasca Valley, and Fort Chipewyan) for three years were used to develop parameters for conversion to NO_2 (following the approach of EnCana 2007). Additional details are presented in Appendix A of the Air Quality Assessment provided in the EIA (MEMS 2011).

To estimate ambient NO_2 concentrations, emissions were first modelled as NO_2 and NO, dispersed without chemical transformation using CALPUFF and then summed for form NO_X. Predicted NO_2 concentrations were then calculated using the ambient ratio method.

2.0 DISPERSION MODELLING APPROACH

2.1 Model Parameters

To ensure consistency with air quality modelling conventions carried out in the oil sands region of Alberta including the 2011 EIA for Phase 2 (MEMS 2011), the CALMET and CALPUFF models were used for the McKay Thermal Project air quality assessment. Use of both the CALMET and CALPUFF models is recommended by Environment and Sustainable Resource Development (ESRD) for regulatory air quality assessments (ESRD, 2009). CALMET is a diagnostic three-dimensional meteorological model and CALPUFF is an advanced non-steady state air quality dispersion model. CALPUFF model parameters are presented in Appendix A of the EIA (MEMS 2011).

The dispersion model was completed using the receptor grid and modelling parameters, as used in the 2011 EIA. Receptors located within both the Phase 1 and Phase 2 site boundaries were removed since the AAAQO typically applies only to areas where public access is not restricted.

2.2 Meteorological Data

The CALMET model used was consistent with the model used in the Phase 2 EIA. In summary, the CALMET modeling domain was 270 km west to east and 305 km north to south. The UTM coordinates (NAD 83, Zone 12) for the modelling domain ranged from 294,000 m to 564,000 m easting, and 6,205,000 m to 6,510,000 m northing (latitude 55° 59’ to 58° 40’ and longitude 109° 58’ to 114° 33’). Horizontal grid cells 5 km x 5 km were adopted for the modelling. For additional detail on the CALMET set up, refer to Appendix A of the Air Quality Assessment provided in the EIA (MEMS 2011).

The 2002-2006 MM5 regional meteorological dataset provided by Environment Canada was used as the meteorological data source. No surface meteorological stations are located within the modelling domain and, as such, no surface meteorology was included in the model.

Figure 2.1 shows the CALMET winds at a location near the Project. At the Project location, the wind is predominately from the west and west-southwest directions.

2.3 Background Concentration

Background concentrations must be considered in the assessment (ESRD, 2009). According to ESRD guidance (ESRD, 2009), appropriate contaminant concentrations due to natural sources, and unidentified, possibly distant sources are to be used as background, and added to predicted values from the facility and nearby sources. For this project, background concentrations of SO_2, NO_x, and $PM_{2.5}$ were obtained from the Fort Chipewyan monitoring station for the period January 2006 – December 2010, while the CO background concentration was obtained from the Fort McMurray monitoring station for the period January 2006 – December 2010. These stations were chosen because they represent air quality conditions most like the ones near the Project. All ambient data is consistent with what was used in the air quality assessment for the 2011 EIA for Phase 2 (MEMS 2011).

According to ESRD (2009), for refined assessments, the 90^{th} percentile from the cumulative frequency distribution should be added as background concentration to the hourly and 24-hour predictions, and the 50^{th} percentile hourly concentration should be added to the annual average. Background concentrations that were added to predictions are listed in Table 2.1.

Table 2.1 Ambient Background Concentrations[a]

	90^{th} Percentile Hourly	90^{th} Percentile 8-Hour	90^{th} Percentile Daily	90^{th} Percentile Monthly	50^{th} Percentile Hourly
SO_2 (µg/m^3)	2.6	n/a	2.6	1.9	0.8
NO_x (µg/m^3)	7.5	n/a	6.2	n/a	2.4
CO (µg/m^3)	344	372[b]	n/a	n/a	n/a
$PM_{2.5}$ (µg/m^3)	5.3	n/a	4.9	n/a	1.4

[a] Data source: CASA (2011).
[b] 90^{th} Percentile 8-hour concentration, based on aggregation of hourly data
n/a averaging period not assessed for constituent

3.0 PROJECT EMISSIONS AND DESIGN

3.1 Project Emissions

Emissions from both the Phase 1 and Phase 2 CPFs will be continuous from steam boilers and generators, and natural gas fired cogeneration units. The utility boilers, glycol heaters and truck flares in both Phase 1 and Phase 2 are intermittent sources but are modelled as continuous sources to provide a conservative estimation of ground-level concentrations.

In order to accommodate the expansion in production capacity at the Phase 1 CPF additional steam and power generation equipment will be required at the Phase 1 CPF. With the reduced production capacity at the Phase 2 CPF the number of emission sources has also been reduced. Modelled stack parameters and emission rates for Phase 1 and Phase 2 are presented in Tables 3.1 and 3.2, respectively.

All stack and emission parameters were provided by STP. NO_x, CO and $PM_{2.5}$ emissions for the truck load-out flare as well as $PM_{2.5}$ emissions for the boilers and heaters were calculated using U.S. EPA AP-42 emission factors (Section 1.4 in US EPA, 2000). CO and $PM_{2.5}$ emissions for the gas turbine were calculated using U.S. EPA AP-42 emission factors (Section 3.1 in US EPA, 2000). SO_2 emissions were estimated on STP reservoir parameters.

The emission intensity of both Phase 1 and Phase 2 steam boilers and generators meet the ESRD Interim NO_x Emission Guidelines (ESRD 2007) and the CCME guidelines for Commercial/Industrial Boilers and Heaters (CCME, 1998). The emission intensity of the glycol and utility heater, when taken as continuous sources exceeds the limit. However, these heaters are intermittent sources, so the total emissions will be lower, and will not likely exceed the emission intensity limit when averaged over total operation. Emission intensity calculations are provided in Section 3.1.1.

NO_x emissions for the co-generation were based upon the assumption that the gas turbine will meet the Best Available Technology Economically Achievable (BATEA) standards set by ESRD for natural gas fired gas turbine units for electricity generation (ESRD, 2007). The compliance limit is based on CASA (2003) or CCME (1992), whichever results in a more stringent limit. Sample calculations for the co-gen units for both Phase 1 and Phase 2 are presented in Section 3.1.1. For both phases the CCME approach to calculating allowable emission intensity results in a more stringent limit; emissions are within the limit.

Table 3.1 Phase 1 Existing and Proposed Stack Parameters and Estimated Emissions

Source Description	UTM Coordinates (m)		Energy Input (MW)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp (K)	Emissions (t/d)			
	Easting	Northing						SO_2	NO_x	CO	$PM_{2.5}$
Existing Emission Sources											
Steam Boiler	424503	6304792	73.3	30.5	1.50	17.3	433	0.25	0.25	0.79	0.020
Steam Boiler	424533	6304792	73.3	30.5	1.50	17.3	433	0.25	0.25	0.79	0.020
Co-Gen Unit #1	424446	6304763	5.7[a] 14.9[b]	20.5	1.20	22.3	462	0.00	0.079	0.092	0.007
Co-Gen Unit #2	424454	6304763	5.7[a] 14.9[b]	20.5	1.20	22.3	462	0.00	0.079	0.092	0.007
Co-Gen Unit #3[c]	424468	6304763	5.7[a] 14.9[b]	20.5	1.20	22.3	462	0.00	0.079	0.092	0.007
Utility Boiler	424328	6304758	3.7	10.1	0.51	5.6	279	0.00	0.008	0.040	0.001
Glycol Heater	424328	6304755	2.5	8.5	0.46	4.2	277	0.00	0.006	0.027	0.001
Truck Flare	424091	6304745	0.0	12.2	0.15	2.7	276	0.00	0.010	0.047	0.001
Proposed Additions											
OTSG	424489	6304865	36.9	30.5	1.20	16.3	450	0.10	0.13	0.40	0.010
OTSG	424496	6304865	36.9	30.5	1.20	16.3	450	0.10	0.13	0.40	0.010
Co-Gen Unit #4	424486	6304760	5.7[a] 14.9[b]	20.5	1.20	22.3	462	0.00	0.079	0.092	0.007
Total Continuous Emissions								**0.71**	**1.10**	**2.86**	**0.09**

[a] Power rating for continuous GTG.
[b] Power rating for continuous HSRG, shown based on heat recovered as steam.
[c] Co-Gen #3 is considered a back-up unit. Emissions are not included in total, as only 3 co-gens are expected to be operating at a given time.

Table 3.2 Phase 2 Proposed Stack Parameters and Estimated Emissions

Source Description	UTM Coordinates (m)		Energy Input (MW)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp (K)	Emissions (t/d)			
	Easting	Northing						SO_2	NO_x	CO	$PM_{2.5}$
Steam Boiler	428921	6304849	106.32	34.0	2.00	17.7	472	0.25	0.37	1.15	0.029
Steam Boiler	428945	6304856	106.32	34.0	2.00	17.7	472	0.25	0.37	1.15	0.029
Steam Boiler	428956	6304859	106.32	34.0	2.00	17.7	472	0.25	0.37	1.15	0.029
Co-Gen Unit #1	429032	6304871	15.0[(a)] 30.5[(b)]	20.5	2.00	22.2	484	0.00	0.42	0.67	0.017
Co-Gen Unit #2	429046	6304875	15.0[(a)] 30.5[(b)]	20.5	2.00	22.2	484	0.00	0.42	0.67	0.017
Utility Boiler #1	429057	6304653	5.92	10.1	0.51	15.9	495	0.00	0.013	0.064	0.002
Utility Boiler #2	429061	6304654	5.92	10.1	0.51	15.9	495	0.00	0.013	0.064	0.002
Glycol Heater #1	429016	6304788	5.05	8.5	0.61	8.4	438	0.00	0.011	0.055	0.001
Glycol Heater #2	429017	6304782	5.05	8.5	0.61	8.4	438	0.00	0.011	0.055	0.001
Truck Flare	429108	6304750	n/a	12.2	0.15	2.8	1273	0.00	0.005	0.016	0.000
Total Continuous Emissions								**0.74**	**1.99**	**5.04**	**0.13**

[(a)] Power rating for continuous GTG.
[(b)] Power rating for continuous HSRG, shown based on heat recovered as steam.

3.1.1 Emission Intensity Sample Calculations

The emission intensity of both Phase 1 and Phase 2 steam boilers and generators meet the ESRD Interim NO_x Emission Guidelines (ESRD 2007) and the CCME guidelines for Commercial/Industrial Boilers and Heaters (CCME, 1998). The emission intensity of the glycol and utility heater, when taken as continuous sources exceeds the limit. However, these heaters are intermittent sources, so the total emissions will be lower, and will not likely exceed the emission intensity limit when averaged over total operation. These calculations are presented to support the data summarized in Table 3.3.

Sample calculation determining the emission intensity from the steam boiler, for comparison against CCME limits:

Phase 1 Steam Boiler input = 263 GJ/hr

Emission Intensity = (Emission rate) / (Heat Input)

Design NO_x emission intensity = 2.93 g/s * 3600 / 263 GJ/hr = 40 g/GJi (within ESRD Compliance (2007) and CCME limits (1998))

CCME emission intensity guideline for NOx = 40 g/GJ_i

Design CO emission intensity = 9.16 g/s * 3600 / 263 GJ/hr = 125 g/GJi (within CCME (1998) limits)

CCME emission guideline for CO = 125 g/GJ_i

Similar calculations can be completed for the OTSGs, glycol heaters and utility boilers. The results of these calculations are summarized in Table 3.3.

Sample calculation determining appropriate co-generation compliance limits for Phase 1 following the CCME Guidelines (1992) is as follows:

Grams of NO_2 equivalent = (Power Output x A) + (Heat Output x B)

Where,

A = Power output allowance for non-peaking turbines (natural gas fired) 3 – 20 MW = 240 g/GJ

B = Heat recovery allowance for natural gas units = 40 g/GJ

(Power Output x A) = 0.0057 GJ/s x 240 g /GJ (for natural gas fired units) = 1.368 g/s

(Heat Output x B) = 0.0149 GJ/s x 40 g/GJ = 0.596 g NO_x/s

Total NO_2 equivalent = 1.368 g/s + 0.596 g/s = 1.96 g/s = 0.17 t/d

Sample calculation determining appropriate co-generation compliance limits for Phase 1 following the CASA Guidelines (2003) is as follows:

NO_x output = Total Output x threshold

The NO_x BATEA standards for new gas-fired units under 20 MW power capacity is 0.6 kg/MWh

= (0.0057 + 0.0149) GJ/s x 0.6 kg/MWh

= 3.43 g/s = 0.42 t/d

Note: The above allowable NO_x emissions under CCME guidelines for cogeneration are greater than the amended approval limits for Phase 1 cogeneration (Approval No. 255245-00-01), which are based on the guaranteed vendor performance for NO_x (0.92 g/s). Emissions used in the model comply with these existing approval limits.

Sample calculation determining appropriate co-generation compliance limits for Phase 2 following the CCME Guidelines (1992) is as follows:

(Power Output x A) = 0.015 GJ/s x 240 g /GJ (for natural gas fired units) = 3.6 g/s

(Heat Output x B) = 0.030 GJ/s x 40 g/GJ = 1.21 g NO_x/s

Total NO_2 equivalent = 3.6 g/s + 1.21 g/s = 4.82 g/s = 0.42 t/d

Following the CASA Guidelines (2003):

NO_x output = Total Output x threshold

The NO_x BATEA standards for new gas-fired units under 20 MW power capacity is 0.6 kg/MWh

= (0.015 + 0.030) GJ/s x 0.6 kg/MWh

= 7.57 g/s = 0.93 t/d

For both Phase 1 and Phase 2, the CCME approach to determining maximum allowable NO_x emissions results in a more stringent guideline. For both Phases, the modelled emissions were within the respective limits.

Table 3.3 CCME and ESRD NO_x and CO Emission and Performance Target Compliance for Boilers and Heaters

Source	Power Rating	Number of Units	Predicted NO_x Emissions Intensity		Predicted CO Emissions Intensity		CCME NO_x Emission Intensity Limit	CCME CO Emission Intensity Limit	ESRD NO_x Compliance Limit	ESRD NO_x Performance Targets
	kW	#	t/d	g/GJ_i	t/d	g/GJ_i	g/GJ_i	g/GJ_i	g/GJ_i	g/GJ_i
Phase 1										
Steam Boiler	73.3	2	0.25	40	0.79	125	40	125	40	15.8
OTSG	36.9	2	0.13	40	0.40	125	40	125	40	15.8
Utility Boiler[(a)]	3.7	1	0.008	26	0.040	125	26	125	n/a	n/a
Glycol Boiler[(a)]	2.5	1	0.006	26	0.027	125	26	125	n/a	n/a
Phase 2										
Steam Boiler	106.3	3	0.37	40	1.15	125	40	125	40	15.8
Utility Boiler[(a)]	5.9	2	0.013	26	0.064	125	26	125	n/a	n/a
Glycol Boiler[(a)]	5.0	2	0.011	26	0.055	125	26	125	n/a	n/a

[(a)] These are intermittent sources; therefore, the actual emissions will be lower.
n/a - ESRD NO_x emission guidelines are only applicable to heaters and boilers with a rating of greater than 10.5 GJ/hr.

Total emissions from the Project are summarized in Table 3.4. Emissions based on the current design are compared to the emissions profile in the 2011 Phase 2 EIA. Overall, the updated facility design provides for a decrease in total emissions for all criteria air contaminants. The Phase 1 SO_2 emissions included in the EIA reflected the maximum emissions allowable before sulphur recovery at the facility would be required, not the previously permitted limit. SO_2 emissions included in the 2012 Project Update are based on engineering design basis, resulting in an apparent net decrease in SO_2 emissions. The previously approved SO_2 emission limit was 0.5 t/d for Phase 1.

STP facilities represent a small source of emissions in the regional inventory included in the 2011 EIA. Table 3.5 shows the change in the total emissions associated with the baseline and application cases with the Project update. The change is less than 1% for each chemical. As Project emissions are roughly < 1% of regional emissions, these changes do not necessitate a reassessment of regional scenarios.

Table 3.4 Emissions Comparison Project Update

Operations	SO_2 (t/d)	NO_x (t/d)	CO (t/d)	$PM_{2.5}$ (t/d)
2011 Application and EIA				
Phase 1 – 2011 EIA	1.90[(a)]	0.71	1.88	0.06
Phase 2 – 2011 EIA	1.15	2.84	6.88	0.16
Total STP EIA Emissions	3.05	3.55	8.76	0.22
2012 Project Update				
Phase 1 – 2012 Project Update	0.71	1.10	2.86	0.09
Phase 2 – 2012 Project Update	0.74	1.99	5.04	0.13
Total STP Update Emissions	1.45	3.09	7.90	0.22
Net Change in Total Project Emissions (%)	***-52***[(a)]	***-13***	***-10***	***0***

[(a)] The Phase 1 SO_2 emissions included in the EIA reflected the maximum emissions allowable before sulphur recovery at the facility would be required, not the previously permitted limit.

Table 3.5 Change in Assessment Case Total Emissions

Assessment Case	SO_2 (t/d)	NO_x (t/d)	CO (t/d)	$PM_{2.5}$(t/d)
Application – 2011 EIA	233	429	468	28
Application – 2012 Update	232	428	467	28
Net Difference (%)	***-0.4***	***-0.2***	***-0.2***	***0***

3.2 Facility Design

The generation of downwash by buildings located within the proposed Project compound was considered in the modelling. Tables 3.6 and 3.7 present the dimensions of the Phase 1 storage tanks and buildings, respectively, considered in the 2012 Update modelling. Phase 2 data is presented in Tables 3.8 and 3.9. A representative plot plan of the buildings, tanks and sources in the CPFs are presented in Figures 3.1 and 3.2.

Table 3.6 Phase 1- Storage Tank Dimensions Information, 2012 update

Drawing Label	Tank Name	Diameter (m)	Height (m)
T1	Oil Production Tank	14.5	9.8
T2	Sales Oil Tank	14.5	9.8
T3	Off Spec. Oil Tank	14.5	9.8
T4	Desand Tank	7.2	9.8
T5	Desand Tank	7.2	9.8
T6	Skim Tank	14.5	9.8
T7	IGF Feed Tank	14.5	9.8
T8	De-Oiled Water Tank	14.5	9.8
T9	Diluent Tank	14.5	9.8
T10	Raw Water Tank	7.2	9.8
T11	Boiler Feedwater Tank	14.5	9.8
T12	Soft Water Tank	14.5	9.8
T13	Steam Generator Blowdown Tank	7.2	9.8
T14	OTSG BWF Tank	7.2	9.9
T15	Slurry Storage Tank	7.2	9.9
T16	Filtration Package Feed Tank	7.2	9.9
T17	Regen Caustic Tank	3.0	3.5
T18	Regen Acid Tank	3.0	3.5
T19	Polishing Softener Feed Tank	7.2	9.9
T20	WAC Regen Waste Tank	3.8	9.0
T21	Glycol POP Tank	1.8	3.0
T22	Glycol Storage Tank	1.8	3.8
T23	OTSG Blowdown Tank	5.3	7.3
T24	Crystallized Feed Tank	4.7	7.3
T25	Crystallizer Waste Tank	4.7	7.3

Note: Dimensions have been rounded for consistency in presentation purposes

Table 3.7 Phase 1 - Building Information Used to Evaluate Downwash, 2012 Update

Drawing Label	Building	Length (m)	Width (m)	Height (m)
B1	MCC-110 Building	30.0	7.0	4.2
B2	MCC-210 Building	30.0	7.0	4.2
B3	North Inlet Building	28.3	7.0	3.6
B4	South Inlet Building	34.0	6.2	6.1
B5	100V-1050 FWKO Building	25.3	4.3	6.3
B6	100V-1060 FWKO Building	25.2	4.3	6.3
B7	100V-1070 Treater Building	25.5	5.4	6.3
B8	Produced Water / Glycol Exchange Building	22.0	13.0	6.9
B9	Clean Oil / Glycol Exchange Building	12.0	6.5	3.8
B10	North Tank Building	76.2	7.0	5.2
B11	South Tank Building	76.2	7.0	5.2
B12	West Water Building	29.5	7.0	5.2
B13	East Water Building	29.5	7.0	5.2
B14	Evaporator/Crystallizer Building	57.0	22.5	15.0
B15	H.P. BFW Pump Building	17.9	7.0	6.0
B16	Steam Generator Building	36.0	31.2	13.3
B17	Fuel Gas Building	12.3	6.0	5.5
B18	Flare Knock-Out Building	12.0	3.8	5.0
B19	Glycol Building	20.0	16.0	4.5
B20	Cogeneration Building	30.3	25.4	10.0
B21	Office / Main Control Building	44.5	19.5	4.9
B22	IGF Building	28.0	7.0	5.0
B23	VRU Building	11.0	6.5	5.0
B24	LP BFW Pump Building	15.0	7.0	4.9
B25	Softener Building	16.0	14.0	6.1
B26	MCC	20.0	7.0	4.2
B27	Cogeneration	31.1	14.0	8.0
B28	OTSG Building	30.0	18.0	6.1
B29	MCC	20.0	7.0	4.2
B30	Inlet Vapor Separator Building	14.0	6.0	6.1
B31	Filtration Building	16.0	7.0	6.1

Note: Dimensions have been rounded for consistency in presentation purposes

Table 3.8 Phase 2 - Storage Tank Dimensions Information, 2012 Update

Drawing Label	Tank Name	Diameter (m)	Height (m)
T1	Boiler Feedwater Tank	20.4	9.8
T2	Soft Water Tank	20.4	9.8
T3	Desand Tanks	7.2	9.8
T4	Skim Tank	24.0	8.5
T5	Surge Tank	19.0	8.5
T6	De-Oiled Water Tank	20.4	9.8
T7	Slop Tanks	7.2	9.8
T8	Diluent Tanks	17.7	9.8
T9	Sales Oil Tank	17.7	9.8
T10	Off Spec. Tank	17.7	9.8
T11	Steam Gen Blowdown Tank	5.3	9.2
T12	Process Waste Tank	5.3	9.2
T13	Oil Production Tank	17.7	9.8
T14	Crystallizer Feed Tank	7.2	9.8
T15	Crystallizer Waste Tank	6.1	8.9
T16	Raw Water Tank	7.1	9.8
T17	Softener Regen Waste Tank	5.3	9.2
T18	Brine Dissolving Tank	3.7	7.9
T19	Cogen Blowdown Tank	5.3	9.2
T20	Glycol Pop Tank	2.5	1.8
T21	Glycol Storage Tank	4.0	7.9
T22	Clean In Place Tank	4.0	7.9
T23	Clean In Place Tank	4.0	7.9

Note: Dimensions have been rounded for consistency in presentation purposes

Table 3.9 Phase 2 - Building Dimensions Information, 2012 Update

Drawing Label	Building ID	Width[(a)] (m)	Length[(b)] (m)	Height (m)
B1	Cogeneration SWG	7.0	30.0	3.7
B2	Black Start Generator	7.0	15.0	3.7
B4	480VAC-MCC	7.0	30.0	4.2
B5	4160VAC – MCC – EVAP	7.0	30.0	4.2
B6	Cogeneration Building	25.0	35.5	10.0
B7	Steam Generation Building	30.0	58.0	13.5
B8	Utility Steam Building	7.0	15.0	4.5
B10	HP BFW Pump Building	7.0	25.0	6.0
B11	4160VAC – MCC – Steam Gen	7.0	30.0	4.2
B12	Evaporator/Water Area Building	23.5	92.0	15.0
B13	Clean Lab	3.7	7.3	2.5
B14	MCC – 1	7.0	30.0	4.2
B15	North Tank Building	7.0	100.0	7.0
B16	South Tank Building	7.0	100.0	7.0
B17	South Inlet Building	7.0	32.0	3.1
B19	North Inlet/Fuel Gas Building	7.0	32.0	6.6
B20	FWKO Buildings	6.2	14.0	6.0
B21	POP Drum Buildings	5.7	10.0	5.0
B22	Treater Buildings	5.6	30.0	6.0
B23	Oil Lab	3.7	7.2	2.8
B24	Production Water / Fuel Gas Building	7.0	16.0	6.5
B25	Clean Oil / Glycol Exchanger Buildings	7.0	12.5	6.5
B27	Instrument Air Package	5.7	9.5	3.7
B28	Glycol Building	18.5	20.0	4.5
B29	Flare Knockout Building	7.0	12.0	5.0
B30	Office / Main Control Room	20.0	45.0	4.9
B31	Warehouse	22.5	50.0	4.9
B33	Dilbit & Diluent Transfer Skid	7.0	10.0	3.7
B34	Plant Utility Building #1	3.0	5.0	2.4
B35	Plant Utility Building #2	3.0	5.0	2.4
B36	Generator	7.0	15.0	2.4
B37	MCC Skid - 2	7.0	25.0	4.2
B38	MCC Skid – 3	7.0	25.0	4.2
B39	Steam Silencer Building	6.0	6.0	3.2
B45	Evaporator Lab	3.7	7.3	2.8
B46	Diluent Offload Building	3.7	5.5	3.1
B47	Cogen Blowdown Pumphouse	4.0	6.0	3.1
B48	Plant Utility Building #2	3.0	5.0	2.4

Table 3.9 Phase 2 - Building Dimensions Information, 2012 Update

Drawing Label	Building ID	Width[(a)] (m)	Length[(b)] (m)	Height (m)
B50	Diluent Offload Building	3.7	5.5	3.0
B51	Warm Storage Building	24.5	50.0	4.9

Note: Dimensions have been rounded for consistency in presentation purposes

3.3 Upset Emissions

The worst case emergency flaring scenario includes a trip or shutdown of the steam plant. In this case, all produced gas would be flared from the pressure control valve at the produced gas separator. The composition provided in Table 3.10 considers the normal gas flow at the produced gas separator and includes gas from the Treaters and the Free Water Knock Out.

Table 3.10 Flare Stack and Emission Parameters: Emergency Flaring – Phase 2

Parameter	Emergency Flaring
Flare Height (m)	39.1
Exit Diameter (m)	0.539
Effective Release Height[(a,b)] (m)	46.2
Pseudo Stack Exit Velocity[(a)] (m/s)	0.53
Pseudo Diameter[(a, c)] (m)	28.7
Pseudo Stack Exit Temperature[(a)] (K)	1284
SO_2 Equivalent mission Rate (g/s)	8.5
Max. Flaring Duration	4 hours
Stream type	Continuous
Flow Rate ($10^3 m^3$/d)	302
Mole Fraction:	
H_2O	0.0442
H_2	0.00
He	0.00
N_2	0.0062
CO_2	0.0383
H_2S	0.0009
CH_4	0.9015
C_2H_6	0.00
C_3H_8	0.0002
$i\text{-}C_4H_{10}$	0.0002

Table 3.10 Flare Stack and Emission Parameters: Emergency Flaring – Phase 2

Parameter	Emergency Flaring
n-C_4H_{10}	0.0002
i-C_5H_{12}	0.002
n-C_5H_{12}	0.002
n-C_6H_{14}	0.004
C_7^+	0.0003
CO	0.00
NH_3	0.00
Total	1.00

(a) At 15 C and 101.3 kPa
(b) Effective release height of plume for CALPUFF modelling
(c) Used in modelling to correspond to exit velocity and actual flow rate

3.4 Greenhouse Gas Emissions

3.4.1 Expected Annual and Total Emissions

Table 3.11 summarizes the annual greenhouse gas (GHG) emissions for the Project. The emission estimates of CO_2, CH_4, and N_2O are based on emission factors and estimated fuel consumption rates. The combustion emission estimates of CO_2, CH_4, and N_2O are based on emission factors (Table 3.11) from the IPCC Emission Factor Database (EFDB) (IPCC, 2006). The fuel consumption rates were estimated based on typical operations at design capacity. GHG emissions for the construction and reclamation phase were based on the estimated equipment fuel consumption from MRCP; Section 2A.2.4, AOSC 2009 (now Dover Operating Corp.) scaled to the Project bitumen production, using IPCC emission factors (IPCC 2006). Detailed methodology is as included in MEMS (2011).

Table 3.11 Summary of GHG Emission Factors

GHG Component	Emission Factor	Units	Source
Natural Gas and Produced Gas Combustion			
CO_2	56	t/TJ_{net}	IPCC Emission Factor Database (EFDB) (2006)
CH_4	1×10^{-4}	t/TJ_{net}	IPCC EFDB (2006)
N_2O	2.4×10^{-4}	t/TJ_{net}	IPCC EFDB (2006)

Table 3.11 Summary of GHG Emission Factors

GHG Component	Emission Factor	Units	Source
Indirect Electricity Purchase			
CO_2e	955	g/kWh	Environment Canada's National Inventory Report (2011), Annex 13, Table A13-10. Electricity Generation and GHG Emission Details for Alberta. Includes a generation intensity of 880 g CO_2e/kWh plus a transmission and distribution loss of 8.5%.

Table 3.12 Summary of Greenhouse Gas Emissions

Project Phase	Direct Emission Rates				Indirect Emission Rates	Overall Total
	CO_2	CH_4	N_2O	CO_2e[(c)]	CO_2e[(c)]	CO_2e[(c)]
Emission Rates [t/y]						
Construction Phase - Phase 2	2.1×10^3	1.2	8.7	2.4×10^3	n/a[(d)]	2.4×10^3
Operations - Phase 1	4.8×10^5	4.7×10^2	20	4.9×10^5	n/a	4.9×10^5
Operations - Phase 2	7.3×10^5	4.7×10^2	31	7.4×10^5	n/a	7.4×10^5
Reclamation Phase - Phase 1 & 2[(a)]	4.0×10^4	2.3	17	4.6×10^4	n/a[(d)]	4.6×10^4
Total Emissions – Project Lifetime [kt]						
Construction Phase - Phase 2	2.1×10^3	1.2	8.7	2.4×10^3	n/a[(d)]	2.4×10^3
Operations - Phase 1[(b)]	1.1×10^7	1.0×10^4	4.5×10^2	1.1×10^7	n/a	1.1×10^7
Operations - Phase 2	1.8×10^7	1.2×10^4	7.8×10^2	1.9×10^7	n/a	1.9×10^7
Decommissioning Phase - Phase 1 & 2	4.0×10^4	2.3	17	4.6×10^4	n/a[(d)]	4.6×10^4
Project Total	2.9×10^7	2.2×10^4	1.3×10^3	3.0×10^7	n/a	3.0×10^7

(a) Annual direct GHG emission rates are based on 98% plant availability. Total emissions are based on a remaining Project life of 22 years for Phase 1 and 25 years for Phase 2.
(b) SF6 and chlorofluorocarbon emissions were considered negligible.
(c) CO_2e = carbon dioxide equivalent.
(d) Indirect emission rates not considered as the project is not importing electricity.

3.4.2 Contribution to Total Provincial and National Greenhouse Gas Emissions

Table 3.13 shows the contribution of the Project operations to total 2009 provincial and national GHG emissions on an annual basis.

Table 3.13 Contribution of the Project to 2009 Provincial and National GHG Emission Inventories During Operations

GHG Emissions	GHG Emissions [Mt CO_2e/year]	% of Alberta Total	% of Canada Total
McKay Phase 1	0.49	0.21	0.07
McKay Phase 2	0.74	0.31	0.11
Alberta Total[(a)]	234		
Canada Total[(a)]	690		

[(a)] Source: Environment Canada (2011) National Inventory Report 1990 to 2009: Greenhouse Gas Sources and Sinks in Canada.
Shaded cells indicate that comparisons between inventories not made.

3.4.3 Greenhouse Gas Emission Intensity

The GHG emission intensity is defined as the amount of GHG emissions generated per barrel of bitumen produced, on an annual average basis.

The intensity during the years in which just Phase 1 is producing is calculated as 80 kg CO_2e/bbl bitumen. The intensity for Phase 2 production alone is 113 kg CO_2e/bbl bitumen. During the years when both Phase 1 and Phase 2 are producing, the combined intensity is estimated to be 97 kg CO2e/bbl bitumen. The difference in the projected GHG emission intensities between the two phases is primarily a result of the difference in the expected SOR. The SOR is expected to be higher in Phase 2 (3.5:1) than in Phase 1 (2.8:1). Moreover, the electrical power demand for Phase 2 is also expected to be higher than in Phase 1 on a per barrel of produced bitumen basis.

These emission intensities are consistent with values ranging from 99 to 176 kg CO2e/bbl synthetic crude oil (SCO) estimated for in-situ project (Charpentier et al., 2009). It should be noted that the emission intensity factors presented in the Charpentier paper are based on upgraded product. If they were converted to a per barrel of bitumen basis by assuming 85 bbls of SCO is produced per every 100 bbls of bitumen, the range would become 116 to 207 kg CO2e/bbl bitumen. Thus, the GHG emission intensity for the Project, without accounting for construction/decommissioning and indirect emissions, is below the low end of this range.

4.0 DISPERSION MODEL PREDICTIONS

Dispersion model predictions for SO_2, NO_2, $PM_{2.5}$ and CO are provided for each averaging period that has associated ambient air quality guidelines or objectives. The 2012 Update predictions presented are the maximum value from the full five years of modelling. An updated Application case is presented, alongside the Application case as presented in MEMS (2011). Predictions reflecting the contributions of the STP facilities (Phase 1 and Phase 2) are also presented. Predictions at the regional and local maximum points of impingement (MPOI), as well as community and residential receptors, as included in MEMS (2011), are presented.

4.1 SO_2

The CALPUFF modelling predictions for SO_2 from the normal operation of the Project are listed in Tables 4.1. The results show that all SO_2 predictions at the Project property boundary line as well as at the MPOI are below the AAAQO. All predictions presented in this section include the background concentrations presented in Table 4.1.

No changes to the Application case predictions were predicted for either the hourly and daily averaging periods. Decreases in the monthly and annual predictions were predicted for LSA-MPOI, and special receptors located within the LSA. As discussed in Section 3.1 the Phase 1 SO_2 emissions included in MEMS (2011) reflected the threshold at which sulphur recovery would be required, not the permitted emissions levels. The Project update was modelled using expected emissions; thus a decrease in predictions was expected.

SO_2 modelling results are also presented in the form of SO_2 concentration contours (isopleths) in Figures 4.1 to 4.4, which show for the 9th highest hourly, 2nd highest daily, maximum monthly and annual predicted concentrations resulting from emissions from STP facilities only (i.e. Project Only Case). For the hourly averaging period, the maximum occurs just beyond the north edge of the Phase 1 CPF. The 2nd highest daily maximum prediction occurs just south of the Phase 1 CPF. Both the maximum monthly and average annual predictions are located between the Phase 1 and Phase 2 facilities.

Table 4.1 Predicted Sulphur Dioxide Concentrations – Application Case

Receptor Location	Application Case – 2011 EIA [μg/m^3]	Application Case – 2012 Update [μg/m^3]	Project Only – 2012 Update [μg/m^3]	Application Case Increase 2012 over 2011 [%]
9th Highest 1-Hour (99.9th Percentile)				
Overall Maximum (RSA-MPOI)	387	387	51	0.0
Local Area Maximum (LSA-MPOI)	295	295	51	0.0
R1 – Kelley McNeilly Cabin	81	81	9.3	0.0
R2 – Damon and Sharon Wright	195	195	6.9	0.0

Table 4.1 Predicted Sulphur Dioxide Concentrations – Application Case

Receptor Location	Application Case – 2011 EIA [µg/m³]	Application Case – 2012 Update [µg/m³]	Project Only – 2012 Update [µg/m³]	Application Case Increase 2012 over 2011 [%]
R3 – Pliska Cabin A	179	179	9.4	0.0
R4 – Pliska Cabin B	134	134	12	0.0
R5 – Pliska Cabin C	61	61	15	0.0
R6 – Powder Cabin A	106	106	9.0	0.0
R7 – MacDonald Cabin B	84	84	5.7	0.0
R8 – Powder Cabin B	83	83	6.8	0.0
R9 – Fort McMurray	66	66	3.5	0.0
R10 – Fort McKay	88	88	3.8	0.0
R11 – Anzac	59	59	3.3	0.0
STP Phase 1 Operations Camp	69	69	19	0.0
STP Phase 2 Operations Camp	81	81	25	0.0
ESRD AAAQO[(a)]	**450**	**450**	**450**	
2nd Highest 24-Hour				
Overall Maximum (RSA-MPOI)	117	117	23	0.0
Local Area Maximum (LSA-MPOI)	60	60	23	0.0
R1 – Kelley McNeilly Cabin	32	32	3.8	0.0
R2 – Damon and Sharon Wright	54	54	3.9	0.0
R3 – Pliska Cabin A	45	45	4.3	0.0
R4 – Pliska Cabin B	38	38	4.6	0.0
R5 – Pliska Cabin C	28	28	8.8	0.0
R6 – Powder Cabin A	31	31	4.0	0.0
R7 – MacDonald Cabin B	29	29	3.7	0.0
R8 – Powder Cabin B	27	26	3.8	0.0
R9 – Fort McMurray	28	28	3.0	0.0
R10 – Fort McKay	29	28	3.0	0.0
R11 – Anzac	26	26	2.8	0.0
STP Phase 1 Operations Camp	26	26	5.7	0.0
STP Phase 2 Operations Camp	28	28	8.2	0.0
ESRD AAAQO[(a)]	**125**	**125**	**125**	
Monthly Maximum				
Overall Maximum (RSA-MPOI)	24	24	5.2	0.0
Local Area Maximum (LSA-MPOI)	12	12	5.2	0.0
R1 – Kelley McNeilly Cabin	5.9	5.8	2.1	-1.7
R2 – Damon and Sharon Wright	11	11	2.1	0.0
R3 – Pliska Cabin A	10	10	2.2	0.0
R4 – Pliska Cabin B	9.4	9.2	2.2	-2.1
R5 – Pliska Cabin C	5.8	5.4	2.7	-6.9
R6 – Powder Cabin A	7.6	6.7	2.1	-12
R7 – MacDonald Cabin B	6.8	6.4	2.1	-5.9

Table 4.1 Predicted Sulphur Dioxide Concentrations – Application Case

Receptor Location	Application Case – 2011 EIA [µg/m³]	Application Case – 2012 Update [µg/m³]	Project Only – 2012 Update [µg/m³]	Application Case Increase 2012 over 2011 [%]
R8 – Powder Cabin B	6.5	6.4	2.1	-1.5
R9 – Fort McMurray	9.5	9.0	2.0	-5.3
R10 – Fort McKay	8.4	8.4	2.0	0.0
R11 – Anzac	7.6	7.6	1.9	0.0
STP Phase 1 Operations Camp	5.6	5.4	2.4	-3.6
STP Phase 2 Operations Camp	7.0	6.1	3.0	-13
ESRD AAAQO[(a)]	**30**	**30**	**30**	
Annual Average				
Overall Maximum (RSA-MPOI)	13	13	2.6	0.0
Local Area Maximum (LSA-MPOI)	6.3	6.3	2.6	0.0
R1 – Kelley McNeilly Cabin	3.3	3.2	0.9	-3.0
R2 – Damon and Sharon Wright	6.0	5.9	0.9	-1.7
R3 – Pliska Cabin A	5.7	5.6	0.9	-1.8
R4 – Pliska Cabin B	4.8	4.6	0.9	-4.2
R5 – Pliska Cabin C	3.5	3.2	1.1	-8.6
R6 – Powder Cabin A	4.6	4.4	0.9	-4
R7 – MacDonald Cabin B	4.0	3.9	0.9	-2.5
R8 – Powder Cabin B	4.1	4.0	0.9	-2.4
R9 – Fort McMurray	5.1	5.1	0.8	0.0
R10 – Fort McKay	5.0	5.0	0.8	0.0
R11 – Anzac	3.8	3.5	0.8	-7.9
STP Phase 1 Operations Camp	3.3	3.2	0.9	-3.0
STP Phase 2 Operations Camp	4.5	3.8	1.5	-16
ESRD AAAQO[(a)]	**20**	**20**	**20**	

[(a)] Source: ESRD (2011).
Shaded Cells: AAAQOs are not applicable to predicted increases.

4.2 NO_2

The CALPUFF modelling predictions for NO_2 from the operation of the Project are listed in Table 4.2. The results show that all NO_2 predictions at the Project property boundary line as well as at the MPOI are below the AAAQO. ESRD (2009) specifies that if ARM is used to determine the relationship between NO_2 and NO_x, then the results using the total conversion method (TCM), which assumes all the NO_x is converted to NO_2, must also be reported. The NO_2 predictions from using both methods are presented in Table 4.2. The TCM is considered a conservative screening approach and it is expected to produce overestimations of NO_2 concentrations. All predictions presented in this section include the background concentrations presented in Table 4.2. The discussion that follows will refer to the results calculated using the ARM method.

In the preparation of this Project Update errata were noted in the 2011 EIA. The reported NO_2 predictions (using the ARM) did not include background concentrations. In addition, the annual predictions at receptors R1 through R10, as calculated via the TCM, were shifted by a receptor value. In order to facilitate the comparison of the 2012 Project Update to the original submissions these errors were corrected, and are presented in Table 4.2.

The Project update did not result in any changes to the Application Case predictions, at MPOIs or special receptors, for any averaging period, with the exception of the Phase 1 Operations Camp. The increase reflects the redistribution of NO_x emissions between the Phase 1 and Phase 2 facilities. The annual prediction (Application case) at the RSA MPOI exceeds the AAAQO; however, this exceedence was present in the Baseline case (MEMS, 2011) and was unchanged by the addition of the Project.

NO_2 modelling results are also presented in the form of NO_2 concentration contours (isopleths) in Figures 4.5 and 4.6, which show for the 9th highest hourly, and annual predicted concentrations. Both the hourly and annual predictions are located on the west side of the Phase 2 facility.

Table 4.2 Predicted Nitrogen Dioxide Concentrations – Application Case

Receptor Location	Application Case – 2011 EIA [μg/m³]	Application Case – 2012 Update [μg/m³]	Project Only – 2012 Update [μg/m³]	Application Case Increase 2012 over 2011 [%]
Total Conversion Method				
9th Highest 1-Hour (99.9th Percentile)				
Overall Maximum (RSA-MPOI)	4968	4968	123	0.0
Local Area Maximum (LSA-MPOI)	1569	1569	123	0.0
R1 – Kelley McNeilly Cabin	221	221	23	0.0
R2 – Damon and Sharon Wright	441	441	25	0.0

Table 4.2 Predicted Nitrogen Dioxide Concentrations – Application Case

Receptor Location	Application Case – 2011 EIA [μg/m^3]	Application Case – 2012 Update [μg/m^3]	Project Only – 2012 Update [μg/m^3]	Application Case Increase 2012 over 2011 [%]
R3 – Pliska Cabin A	387	387	21	0.0
R4 – Pliska Cabin B	323	323	28	0.0
R5 – Pliska Cabin C	222	221	31	0.0
R6 – Powder Cabin A	443	443	37	0.0
R7 – MacDonald Cabin B	552	552	24	0.0
R8 – Powder Cabin B	425	425	18	0.0
R9 – Fort McMurray	298	298	21	0.0
R10 – Fort McKay	1254	1254	10	0.0
R11 – Anzac	131	131	9	0.0
STP Phase 1 Operations Camp	238	238	66	0.0
STP Phase 2 Operations Camp	290	290	61	0.0
ESRD AAAQO[(a)]	**300**	**300**	**300**	
Annual Average				
Overall Maximum (RSA-MPOI)	418	418	10	0.0
Local Area Maximum (LSA-MPOI)	74	74	10	0.0
R1 – Kelley McNeilly Cabin	13	13	2.7	0.0
R2 – Damon and Sharon Wright	24	24	2.7	0.0
R3 – Pliska Cabin A	23	23	2.8	0.0
R4 – Pliska Cabin B	20	20	2.8	0.0
R5 – Pliska Cabin C	14	14	3.2	0.0
R6 – Powder Cabin A	27	27	2.8	0.0
R7 – MacDonald Cabin B	32	32	2.7	0.0
R8 – Powder Cabin B	25	25	2.8	0.0
R9 – Fort McMurray	45	45	2.5	0.0
R10 – Fort McKay	93	93	2.5	0.0
R11 – Anzac	11	11	2.4	0.0
STP Phase 1 Operations Camp	17	18	6.5	5.9
STP Phase 2 Operations Camp	19	19	6.3	0.0
ESRD AAAQO[(a)]	**45**	**45**	**45**	
Ambient Ratio Method				
9th Highest 1-Hour (99.9th Percentile)				
Overall Maximum (RSA-MPOI)	281	281	70	0.0
Local Area Maximum (LSA-MPOI)	167	167	70	0.0
R1 – Kelley McNeilly Cabin	75	75	25	0.0
R2 – Damon and Sharon Wright	94	94	21	0.0

Table 4.2 Predicted Nitrogen Dioxide Concentrations – Application Case

Receptor Location	Application Case – 2011 EIA [μg/m^3]	Application Case – 2012 Update [μg/m^3]	Project Only – 2012 Update [μg/m^3]	Application Case Increase 2012 over 2011 [%]
R3 – Pliska Cabin A	89	89	28	0.0
R4 – Pliska Cabin B	82	82	31	0.0
R5 – Pliska Cabin C	75	75	37	0.0
R6 – Powder Cabin A	94	94	24	0.0
R7 – MacDonald Cabin B	104	104	18	0.0
R8 – Powder Cabin B	93	93	21	0.0
R9 – Fort McMurray	79	79	10	0.0
R10 – Fort McKay	151	151	11	0.0
R11 – Anzac	70	70	9.5	0.0
STP Phase 1 Operations Camp	75	75	65	0.0
STP Phase 2 Operations Camp	75	78	61	4.0
ESRD AAAQO[(a)]	**300**	**300**	**300**	
Annual Average				
Overall Maximum (RSA-MPOI)	63	63	10	0.0
Local Area Maximum (LSA-MPOI)	28	28	10	0.0
R1 – Kelley McNeilly Cabin	13	13	2.7	0.0
R2 – Damon and Sharon Wright	17	17	2.7	0.0
R3 – Pliska Cabin A	17	17	2.8	0.0
R4 – Pliska Cabin B	15	15	2.8	0.0
R5 – Pliska Cabin C	13	13	3.2	0.0
R6 – Powder Cabin A	18	18	2.8	0.0
R7 – MacDonald Cabin B	19	19	2.7	0.0
R8 – Powder Cabin B	17	17	2.9	0.0
R9 – Fort McMurray	23	23	2.5	0.0
R10 – Fort McKay	32	32	2.5	0.0
R11 – Anzac	11	11	2.4	0.0
STP Phase 1 Operations Camp	14	15	6.5	7.1
STP Phase 2 Operations Camp	15	15	6.3	0.0
ESRD AAAQO[(a)]	**45**	**45**	**45**	

[(a)] Source: ESRD (2011).
Shaded Cells: AAAQOs are not applicable to predicted increases.

4.3 CO

The CALPUFF modelling predictions for CO from the operation of Project Phases 1 and 2 are listed in Table 4.3.

No changes at either the local or regional MPOIs for CO were predicted for either the hourly or the 8-hour averaging period. The changes predicted at the special receptors, and in particular at the two operations camps, reflect the redistribution of emissions between the Phase 1 and Phase 2 facilities.

Figures 4.8 and 4.9 show the 9th highest hourly and 8-hour maximum contours, respectively, base on STP emissions only. For both averaging periods, the background accounts for over 40% of the reported predictions. The maximum predictions for each averaging period are located along the south side of the Phase 1 facility.

Table 4.3 Predicted Carbon Monoxide Concentrations

Receptor Location	Application Case – 2011 EIA [μg/m³]	Application Case – 2012 Update [μg/m³]	Project Only – 2012 Update [μg/m³]	Application Case Increase 2012 over 2011 [%]
9th Highest 1-Hour				
Overall Maximum (RSA-MPOI)	5070	5070	773	0.0
Local Area Maximum (LSA-MPOI)	1052	1052	773	0.0
R1 – Kelley McNeilly Cabin	516	516	374	0.0
R2 – Damon and Sharon Wright	727	727	367	0.0
R3 – Pliska Cabin A	671	671	380	0.0
R4 – Pliska Cabin B	610	610	387	0.0
R5 – Pliska Cabin C	532	536	399	0.8
R6 – Powder Cabin A	721	721	378	0.0
R7 – MacDonald Cabin B	766	766	363	0.0
R8 – Powder Cabin B	698	698	368	0.0
R9 – Fort McMurray	897	897	350	0.0
R10 – Fort McKay	1450	1450	352	0.0
R11 – Anzac	579	579	348	0.0
STP Phase 1 Operations Camp	559	626	623	12
STP Phase 2 Operations Camp	590	588	491	-0.3
ESRD AAAQO[(a)]	**15,000**	**15,000**	**15,000**	
Maximum 8-Hour Average				
Overall Maximum (RSA-MPOI)	4573	4573	735	0.0
Local Area Maximum (LSA-MPOI)	1144	1144	735	0.0
R1 – Kelley McNeilly Cabin	548	548	393	0.0
R2 – Damon and Sharon Wright	797	797	393	0.0
R3 – Pliska Cabin A	725	725	402	0.0
R4 – Pliska Cabin B	651	650	398	-0.2
R5 – Pliska Cabin C	533	534	408	0.2
R6 – Powder Cabin A	734	734	394	0.0

Table 4.3 Predicted Carbon Monoxide Concentrations

Receptor Location	Application Case – 2011 EIA [μg/m³]	Application Case – 2012 Update [μg/m³]	Project Only – 2012 Update [μg/m³]	Application Case Increase 2012 over 2011 [%]
R7 – MacDonald Cabin B	818	818	384	0.0
R8 – Powder Cabin B	736	736	387	0.0
R9 – Fort McMurray	877	877	377	0.0
R10 – Fort McKay	1407	1407	379	0.0
R11 – Anzac	558	558	376	0.0
STP Phase 1 Operations Camp	557	581	562	4.3
STP Phase 2 Operations Camp	586	586	473	0.0
ESRD AAAQO[(a)]	**6,000**	**6,000**	**6,000**	

[(a)] Source: ESRD (2011).
Shaded Cells: AAAQOs are not applicable to predicted increases.

4.4 $PM_{2.5}$

The CALPUFF modelling predictions for $PM_{2.5}$ from the operation of the Project are listed in Table 4.4 and include secondary particulate. The AAAQG for the 9th highest hourly prediction is exceeded at the RSA MPOI. The AAAQO for the 2nd highest daily prediction is exceeded at both the RSA MPOI and LSA MPOI. These exceedances exist in the Baseline Case (as presented in MEMS, 2011), and were not increased by the addition of the Project.

The Project update did not result in a net change in total $PM_{2.5}$ emissions. As presented in Table 4.4, the Project update did not result in any changes to the predictions at the local or regional maxima. Changes in the predictions at special receptors reflect the redistribution of emissions between the Phase 1 and Phase 2 facilities.

No predictions are provided for the annual averaging period as there is no annual AAAQO for $PM_{2.5}$. Figure 4.7 shows the 2nd highest daily concentration contours, for STP Facility contributions, with the maximum value on the south side of the Phase 1 CPF.

Table 4.4 Predicted $PM_{2.5}$ Concentrations

Receptor Location	Application Case – 2011 EIA [μg/m³]	Application Case – 2012 Update [μg/m³]	Project Only – 2012 Update [μg/m³]	Application Case Increase 2012 over 2011 [%]
9th Highest 1-Hour				
Overall Maximum (RSA-MPOI)	222	222	17	0.0
Local Area Maximum (LSA-MPOI)	72	72	17	0.0

Table 4.4 Predicted $PM_{2.5}$ Concentrations

Receptor Location	Application Case – 2011 EIA [μg/m³]	Application Case – 2012 Update [μg/m³]	Project Only – 2012 Update [μg/m³]	Application Case Increase 2012 over 2011 [%]
R1 – Kelley McNeilly Cabin	40	40	6.4	0.0
R2 – Damon and Sharon Wright	46	46	6.5	0.0
R3 – Pliska Cabin A	47	47	6.7	0.0
R4 – Pliska Cabin B	45	45	7.2	0.0
R5 – Pliska Cabin C	38	37	7.1	-2.6
R6 – Powder Cabin A	49	49	6.4	0.0
R7 – MacDonald Cabin B	57	57	6.0	0.0
R8 – Powder Cabin B	46	46	6.0	0.0
R9 – Fort McMurray	57	57	5.6	0.0
R10 – Fort McKay	75	75	5.6	0.0
R11 – Anzac	24	24	5.5	0.0
STP Phase 1 Operations Camp	38	38	13	0.0
STP Phase 2 Operations Camp	40	40	9.7	0.0
ESRD AAAQG[(a)]	**80**	**80**	**80**	
8th Highest 24-Hour (98th Percentile)				
Overall Maximum (RSA-MPOI)	77	77	9	0.0
Local Area Maximum (LSA-MPOI)	25	25	9	0.0
R1 – Kelley McNeilly Cabin	13	13	5.0	0.0
R2 – Damon and Sharon Wright	18	18	5.0	0.0
R3 – Pliska Cabin A	17	17	5.1	0.0
R4 – Pliska Cabin B	16	16	5.1	0.0
R5 – Pliska Cabin C	14	14	5.3	0.0
R6 – Powder Cabin A	18	18	5.1	0.0
R7 – MacDonald Cabin B	18	18	5.0	0.0
R8 – Powder Cabin B	17	17	5.1	0.0
R9 – Fort McMurray	21	21	4.9	0.0
R10 – Fort McKay	26	26	5.0	0.0
R11 – Anzac	11	10	4.9	-9.1
STP Phase 1 Operations Camp	14	15	7.0	7.1
STP Phase 2 Operations Camp	16	16	6.3	0.0
Canada Wide Standard[(b)]	**30**	**30**	**30**	
2nd Highest 24-Hour				
Overall Maximum (RSA-MPOI)	93	93	11	0.0
Local Area Maximum (LSA-MPOI)	34	34	11	0.0
R1 – Kelley McNeilly Cabin	20	20	5.2	0.0

Table 4.4 Predicted $PM_{2.5}$ Concentrations

Receptor Location	Application Case – 2011 EIA [µg/m³]	Application Case – 2012 Update [µg/m³]	Project Only – 2012 Update [µg/m³]	Application Case Increase 2012 over 2011 [%]
R2 – Damon and Sharon Wright	25	25	5.2	0.0
R3 – Pliska Cabin A	25	25	5.3	0.0
R4 – Pliska Cabin B	23	23	5.3	0.0
R5 – Pliska Cabin C	21	21	5.7	0.0
R6 – Powder Cabin A	28	28	5.2	0.0
R7 – MacDonald Cabin B	28	28	5.1	0.0
R8 – Powder Cabin B	27	27	5.1	0.0
R9 – Fort McMurray	31	31	5.0	0.0
R10 – Fort McKay	36	36	5.0	0.0
R11 – Anzac	14	14	5.0	0.0
STP Phase 1 Operations Camp	21	21	7.8	0.0
STP Phase 2 Operations Camp	24	24	6.9	0.0
ESRD AAAQO[(a)]	**30**	**30**	**30**	

[(a)] Source: ESRD (2011).
[(6)] Source: CCME (2000).
Shaded Cells: AAAQOs are not applicable to predicted increases.

4.5 Upset Flaring

The predicted 99.9th percentile hourly SO_2 prediction of this worst-case upset release scenario (described in Section 3.3) at the MPOI is 387 µg/m³, which is less than the AAAQO of 450 µg/m³, and is the same as under normal operating conditions. The maximum predicted concentration from the Project during flaring is 52 µg/m³. This means that the operation of the flare under this upset scenario will have negligible impact on air quality.

5.0 CONCLUSION

The changes to Project design and layout for the STP McKay Thermal Project, Phase 1 and Phase 2, resulted in a net decrease in overall emissions. The Project air dispersion modelling, based on the new design, indicates the effect of project emissions is localized to the area immediately surrounding the project development. The conclusions of MEMS (2011) with respect to the impact of the Project on air quality are therefore unchanged.

6.0 REFERENCES

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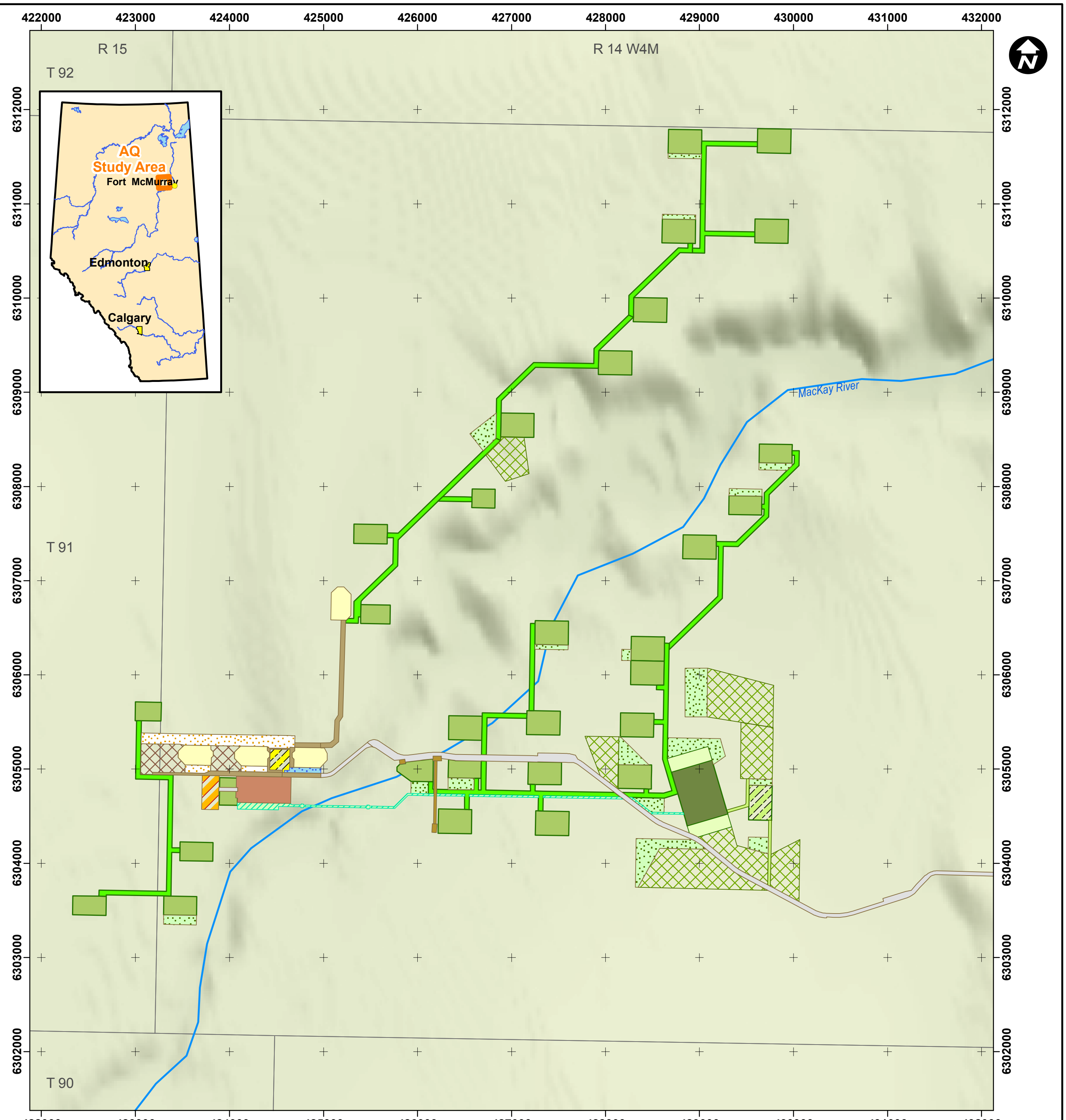


Legend

Phase 1 Facilities
- CPF
- Well Pad
- Utility Corridor
- Borrow Pit
- Construction Camp
- Operations Camp
- Soil Storage
- Access Road
- Water Source Well
- Sedimentation Pond

Phase 2 Facilities
- CPF
- Well Pad
- Construction and Operations Camp
- Utility Corridor
- Access Road
- Temporary Workspace
- Borrow Pit
- Interconnect
- Soil Storage

Topography (masl)
- High : 800
- Low : 200

0 0.75 1.5 3
Kilometers

SOUTHERN PACIFIC RESOURCE CORP.

STP McKay Thermal Project - Phase 2

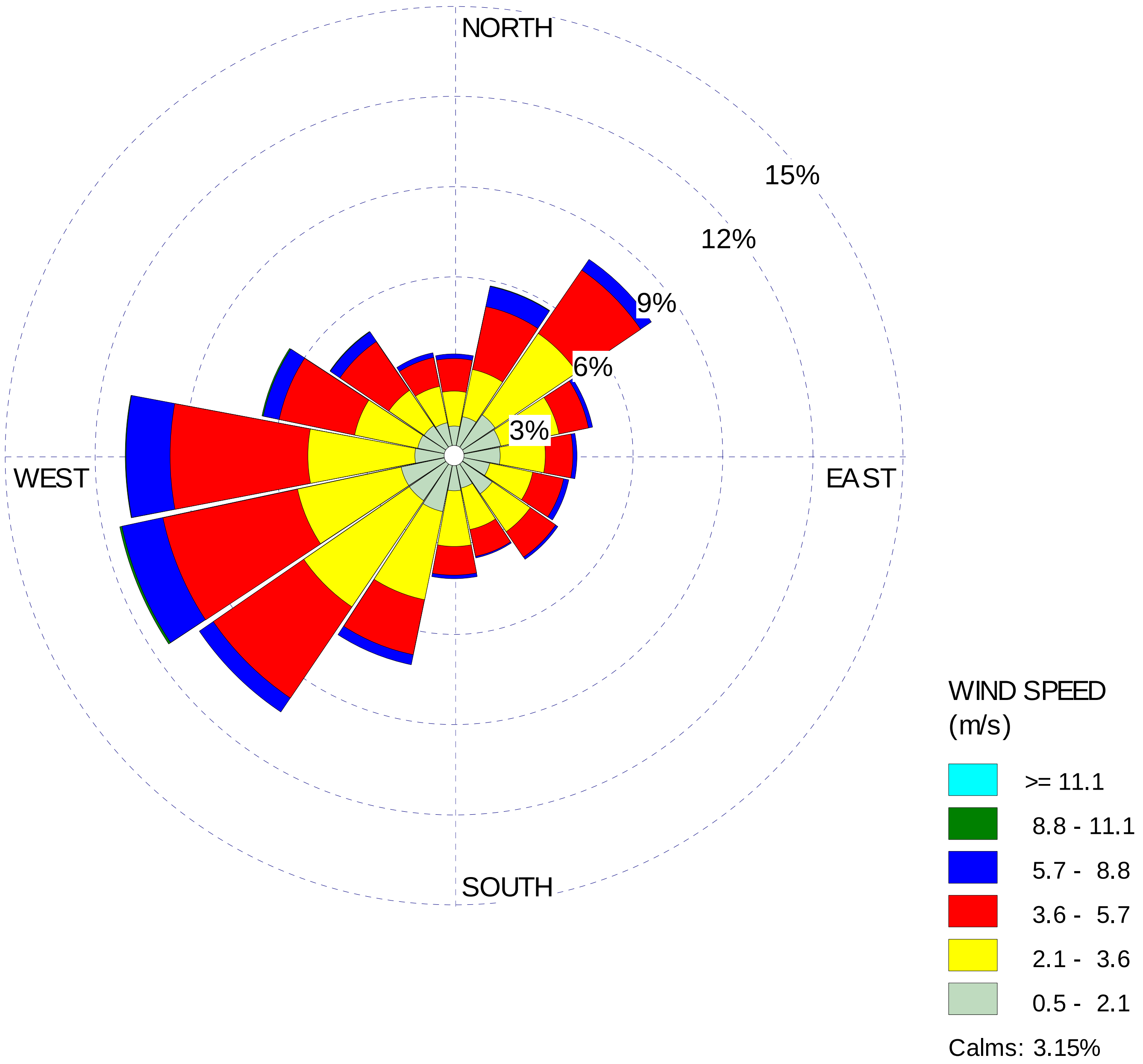
Millennium EMS Solutions Ltd.

TITLE:
STP McKay Thermal Project Phase 1 and Phase 2

DRAWN: JG
CHECKED: EL
DATE: Oct 22/12
PROJECT: 10-037

FIGURE:
1.1

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel\Fig 1.1 Phase 1 and Phase 2.mxd) 10/22/2012 -- 11:38:03 AM



SOUTHERN PACIFIC RESOURCE CORP.

STP McKay Thermal Project - Phase 2

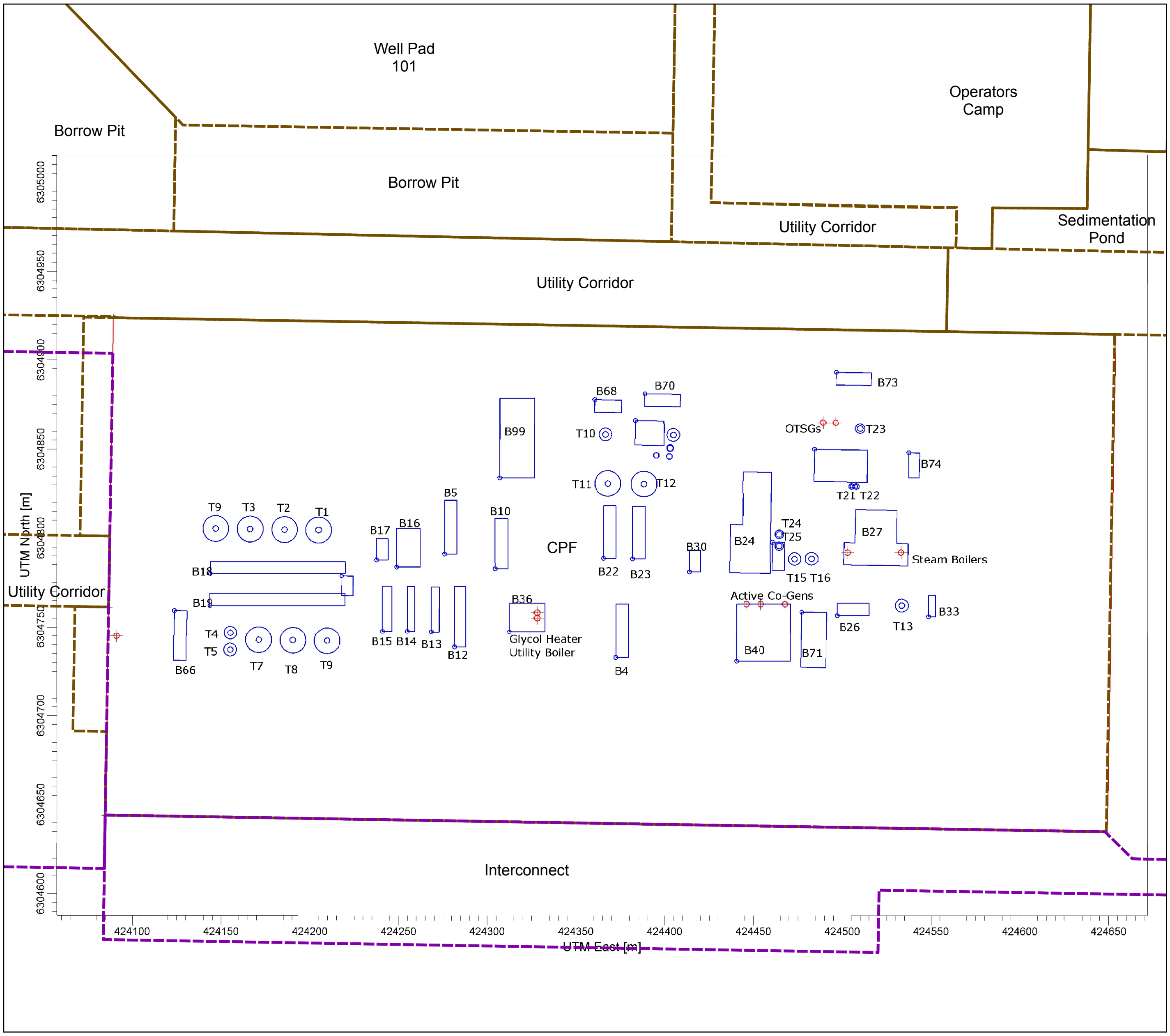
Millennium EMS Solutions Ltd.

TITLE:

Wind Roses from CALMET Model Output at the Project Site, 2002 to 2006

DRAWN:	SL/JG
CHECKED:	EL
DATE:	Aug 2/12
PROJECT:	10-037
FIGURE:	2.1

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel_02Aug12\Fig 2.1 Wind Roses from CALMET.mxd) 8/2/2012 -- 5:08:12 PM



Legend

- Approved Phase 1 Development
- Proposed Initial Phase 2 Development

0 50 100 200
Meters

SOUTHERN PACIFIC
RESOURCE CORP.

STP McKay Thermal Project - Phase 2

Millennium
EMS Solutions Ltd.

TITLE: **Phase 1 Plot Plan Showing the Location of Sources and Buildings included in the Modelling**

DRAWN:	JG
CHECKED:	EL
DATE:	Oct 22/12
PROJECT:	10-037

FIGURE: **3.1**

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel\Fig 3.1 Phase 1 Plot Plan.mxd) 10/22/2012 -- 11:55:00 AM

Legend

Proposed Initial Phase 2 Development

SOUTHERN PACIFIC RESOURCE CORP.

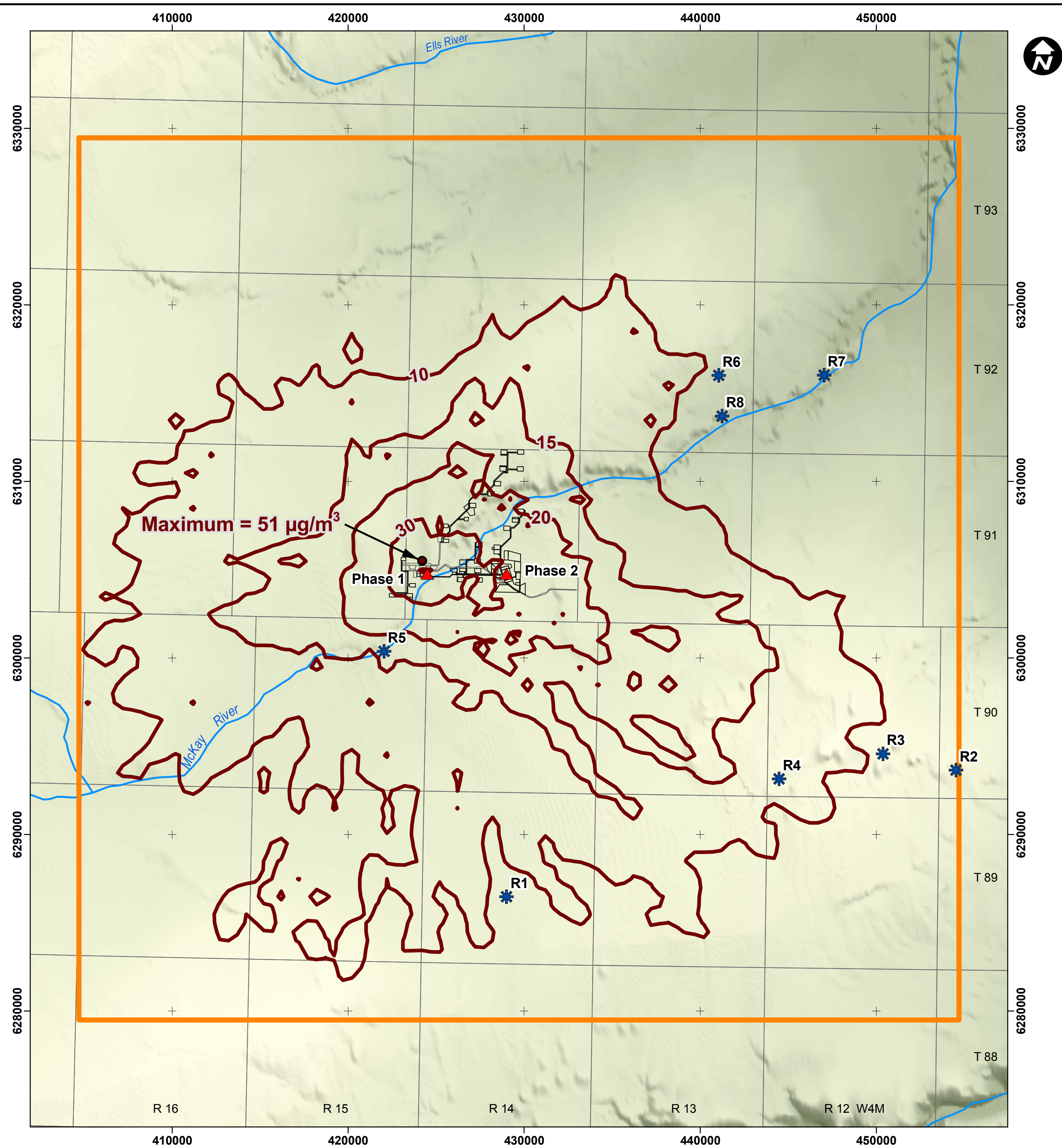
STP McKay Thermal Project - Phase 2

TITLE: **Phase 2 Plot Plan Showing the Location of Sources and Buildings included in the Modelling**

Millennium EMS Solutions Ltd.

DRAWN:	JG
CHECKED:	EL
DATE:	Oct 22/12
PROJECT:	10-037
FIGURE:	3.2

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel\Fig 3.2 Phase 2 Plot Plan.mxd) 10/22/2012 -- 11:44:38 AM



0 2.5 5 10
Kilometres

Legend

- AQ Local Study Area
- Approved Phase 1 Development
- Proposed Initial Phase 2 Development
- Isopleth Concentration

Topography (masl)

High : 800

Low : 200

Receptors	
R1	Kelley McNeilly Cabin
R2	Damon and Sharon Wright
R3	Pliska Cabin A
R4	Pliska Cabin B
R5	Pliska Cabin C
R6	Powder Cabin A
R7	MacDonald Cabin B
R8	Powder Cabin B

SOUTHERN PACIFIC RESOURCE CORP.

Millennium EMS Solutions Ltd.

STP McKay Thermal Project - Phase 2

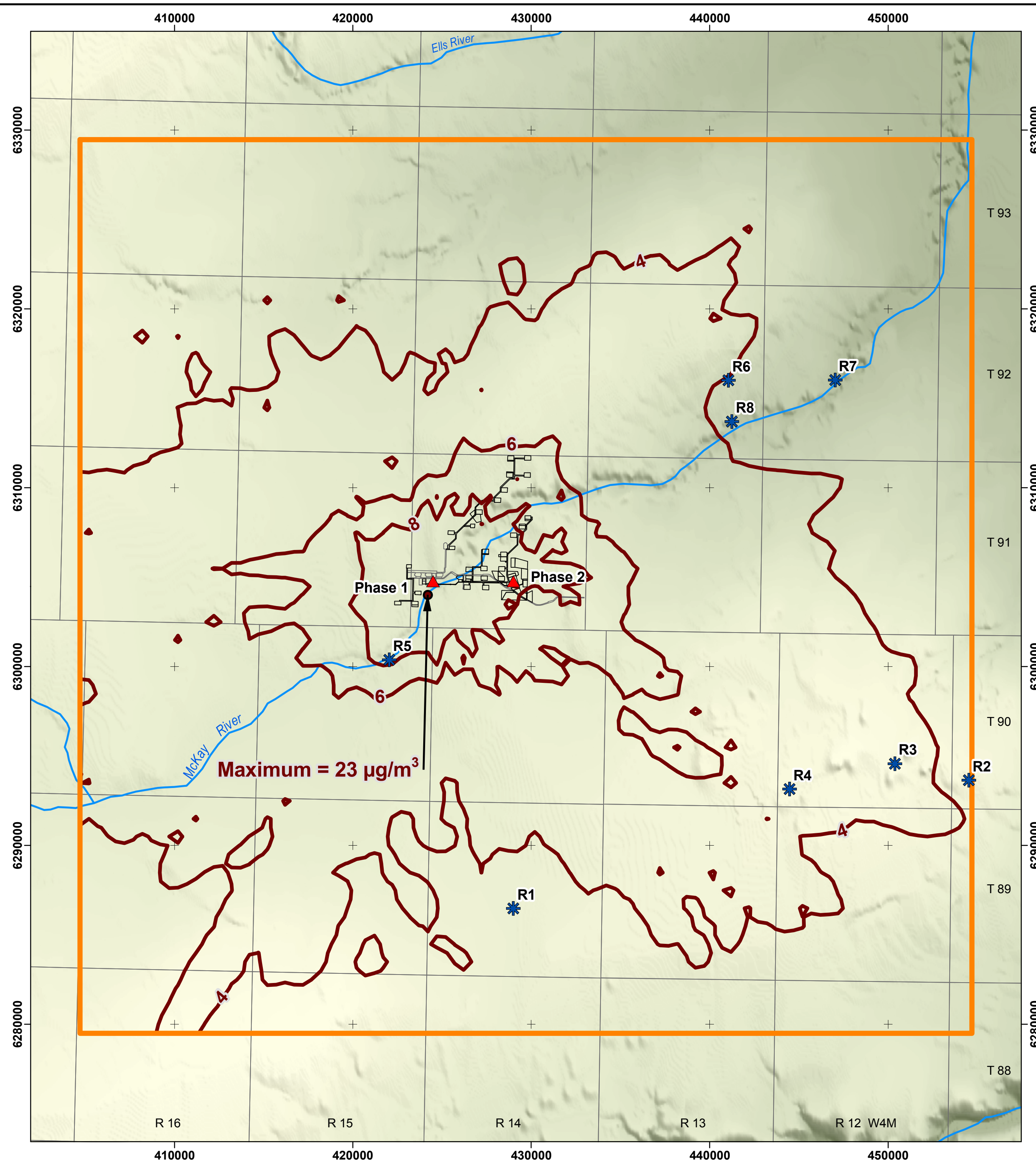
TITLE:

Predicted 9th Highest Hourly SO_2 Concentration (µg/m³) - Project Case

DRAWN: JG
CHECKED: EL
DATE: Oct 22/12
PROJECT: 10-037

FIGURE: 4.1

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel\Fig 4.1 Hourly SO2.mxd) 10/22/2012 -- 1:05:15 PM



0 2.5 5 10
Kilometres

Legend

- AQ Local Study Area
- Approved Phase 1 Development
- Proposed Initial Phase 2 Development
- Isopleth Concentration

Topography (masl)
High : 800
Low : 200

Receptors	
R1	Kelley McNeilly Cabin
R2	Damon and Sharon Wright
R3	Pliska Cabin A
R4	Pliska Cabin B
R5	Pliska Cabin C
R6	Powder Cabin A
R7	MacDonald Cabin B
R8	Powder Cabin B

SOUTHERN PACIFIC RESOURCE CORP.

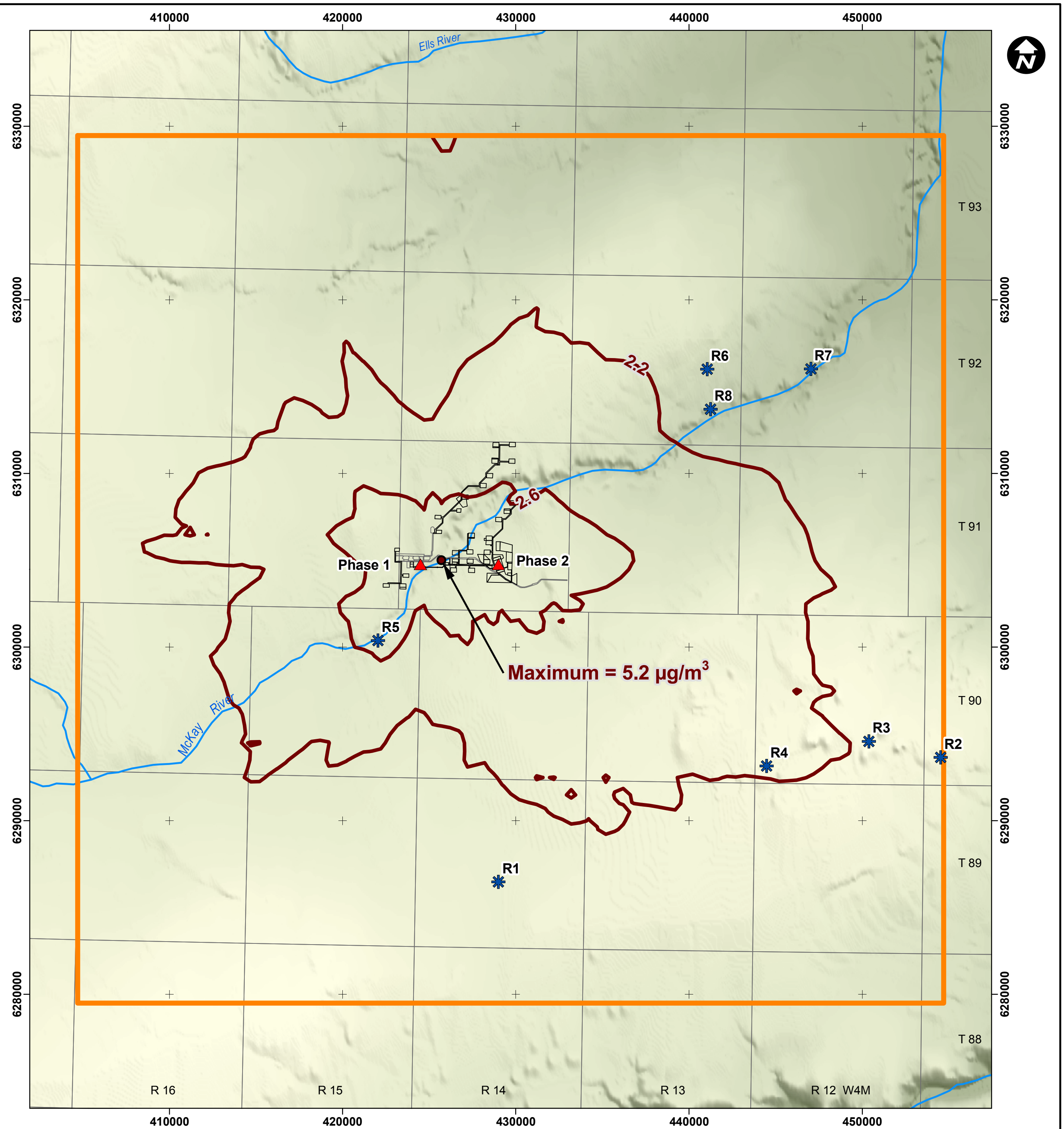
STP McKay Thermal Project - Phase 2

Millennium EMS Solutions Ltd.

TITLE:
Predicted 2nd Highest Daily SO_2 Concentration (µg/m³) - Project Case

DRAWN: JG
CHECKED: EL
DATE: Oct 22/12
PROJECT: 10-037
FIGURE: 4.2

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel\Fig 4.2 Daily SO2.mxd) 10/22/2012 -- 1:07:28 PM



0 2.5 5 10
Kilometres

Legend

AQ Local Study Area

Isopleth Concentration

Topography (masl)

High : 800

Low : 200

Receptors	
R1	Kelley McNeilly Cabin
R2	Damon and Sharon Wright
R3	Pliska Cabin A
R4	Pliska Cabin B
R5	Pliska Cabin C
R6	Powder Cabin A
R7	MacDonald Cabin B
R8	Powder Cabin B

SOUTHERN PACIFIC RESOURCE CORP.

STP McKay Thermal Project - Phase 2

Millennium EMS Solutions Ltd.

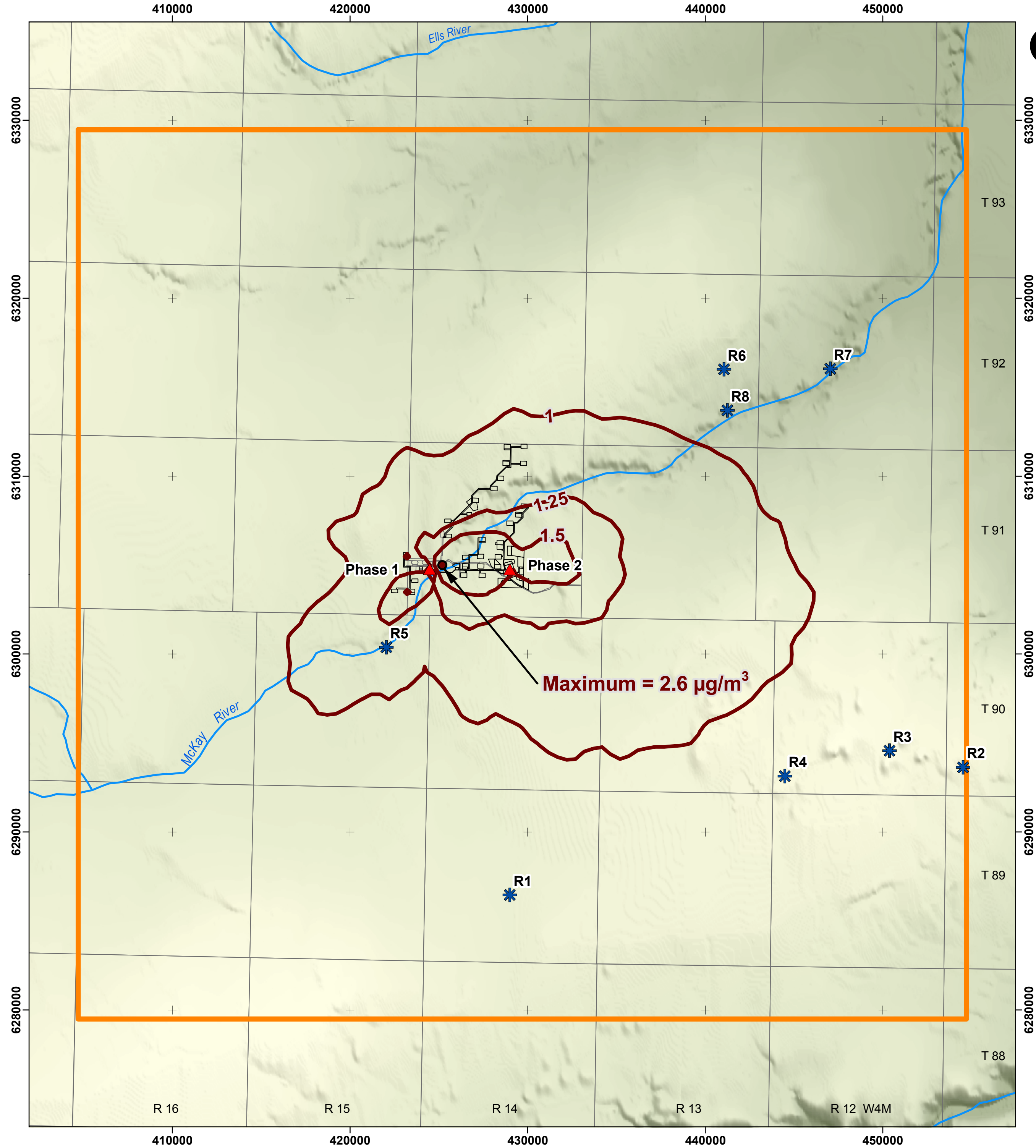
TITLE:

Predicted Maximum Monthly SO_2 Concentration (µg/m³) - Project Case

DRAWN: JG
CHECKED: EL
DATE: Sep 28/12
PROJECT: 10-037

FIGURE: 4.3

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel\Fig 4.3 Monthly SO2.mxd) 9/28/2012 -- 2:59:42 PM



0 2.5 5 10

Kilometres

Legend

- AQ Local Study Area
- Approved Phase 1 Development
- Proposed Initial Phase 2 Development
- Isopleth Concentration

Topography (masl)

High : 800

Low : 200

Receptors	
R1	Kelley McNeilly Cabin
R2	Damon and Sharon Wright
R3	Pliska Cabin A
R4	Pliska Cabin B
R5	Pliska Cabin C
R6	Powder Cabin A
R7	MacDonald Cabin B
R8	Powder Cabin B

SOUTHERN PACIFIC RESOURCE CORP.

STP McKay Thermal Project - Phase 2

Millennium EMS Solutions Ltd.

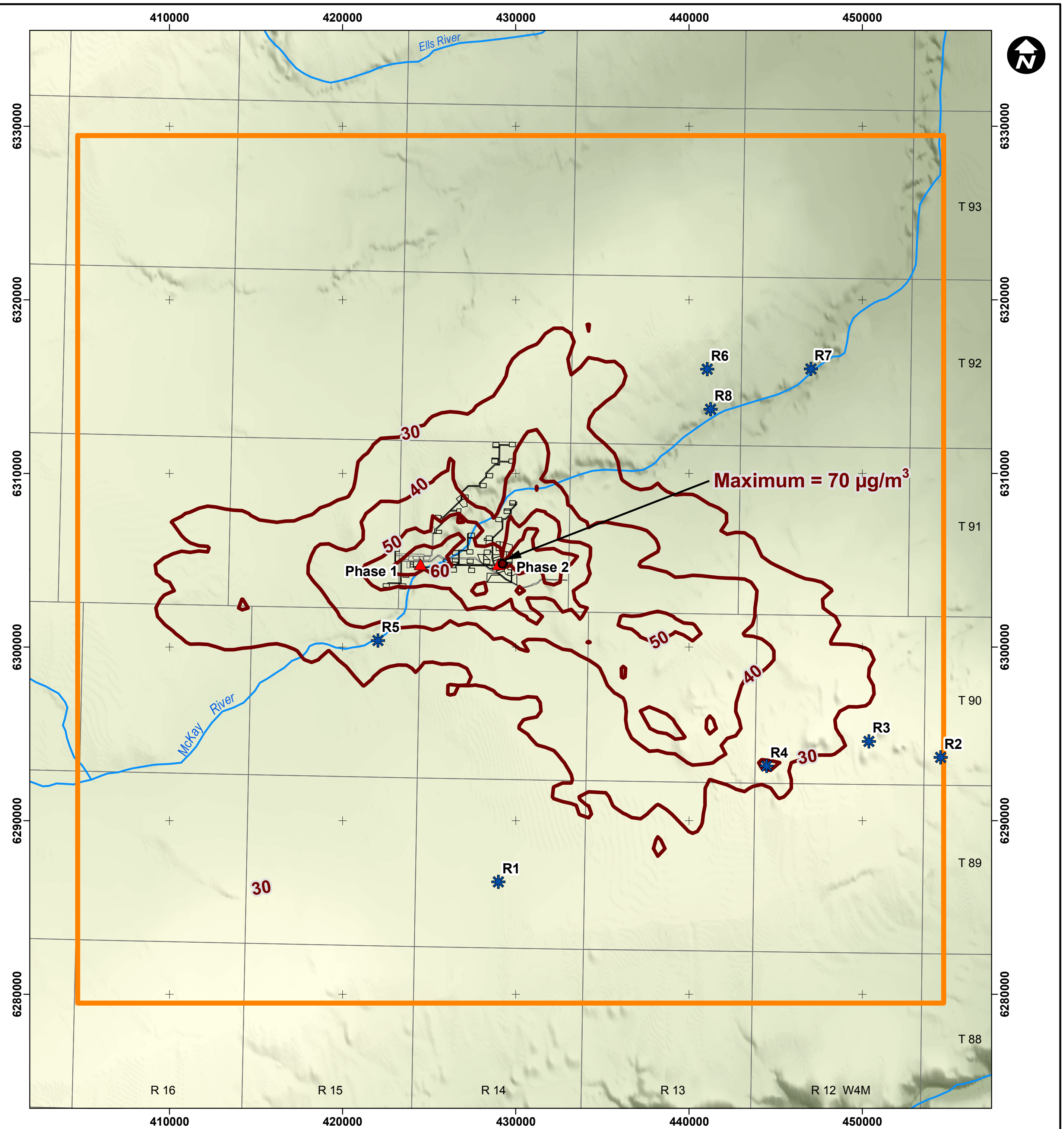
TITLE:

Predicted Annual SO_2 Concentration (µg/m³) - Project Case

DRAWN:	JG
CHECKED:	EL
DATE:	Oct 22/12
PROJECT:	10-037

FIGURE: 4.4

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel\Fig 4.4 Annual SO2.mxd) 10/22/2012 -- 1:14:42 PM



0 2.5 5 10

Kilometres

Legend

- AQ Local Study Area
- Approved Phase 1 Development
- Proposed Initial Phase 2 Development
- Isopleth Concentration

Topography (masl)

High : 800

Low : 200

Receptors	
R1	Kelley McNeilly Cabin
R2	Damon and Sharon Wright
R3	Pliska Cabin A
R4	Pliska Cabin B
R5	Pliska Cabin C
R6	Powder Cabin A
R7	MacDonald Cabin B
R8	Powder Cabin B

SOUTHERN PACIFIC RESOURCE CORP.

STP McKay Thermal Project - Phase 2

Millennium EMS Solutions Ltd.

TITLE:

Predicted 9th Highest Hourly NO_2 Concentration ($\mu g/m^3$) - Project Case

DRAWN: JG

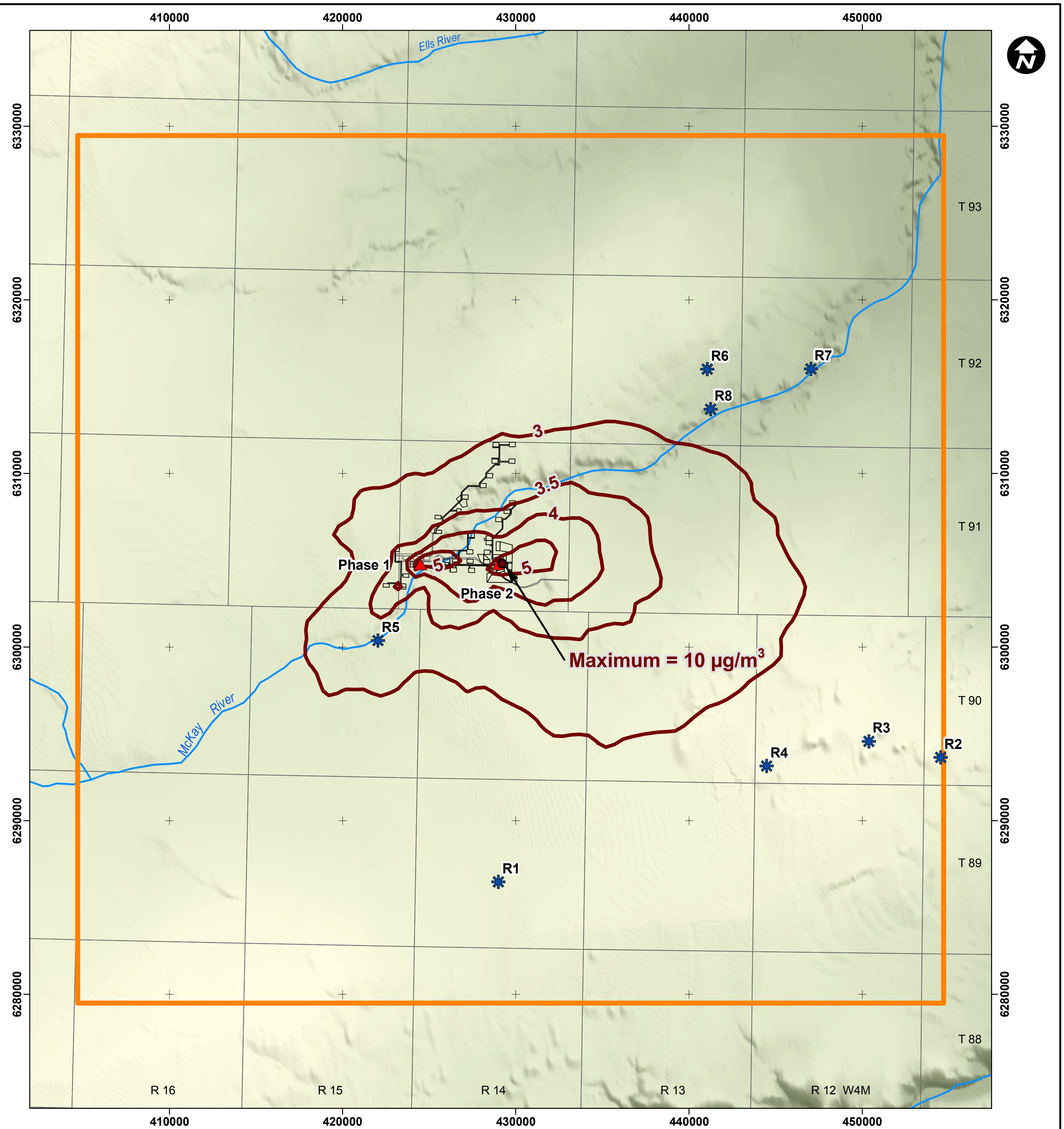
CHECKED: EL

DATE: Oct 22/12

PROJECT: 10-037

FIGURE: 4.5

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel\Fig 4.5 Hourly NO2.mxd) 10/22/2012 -- 1:17:00 PM



0 2.5 5 10
Kilometres

Legend

- AQ Local Study Area
- Approved Phase 1 Development
- Proposed Initial Phase 2 Development
- Isopleth Concentration

Topography (masl)

High : 800

Low : 200

Receptors	
R1	Kelley McNeilly Cabin
R2	Damon and Sharon Wright
R3	Pliska Cabin A
R4	Pliska Cabin B
R5	Pliska Cabin C
R6	Powder Cabin A
R7	MacDonald Cabin B
R8	Powder Cabin B

SOUTHERN PACIFIC RESOURCE CORP.

STP McKay Thermal Project - Phase 2

Millennium EMS Solutions Ltd.

TITLE:

Predicted Annual NO_2 Concentration (µg/m³) - Project Case

DRAWN: JG

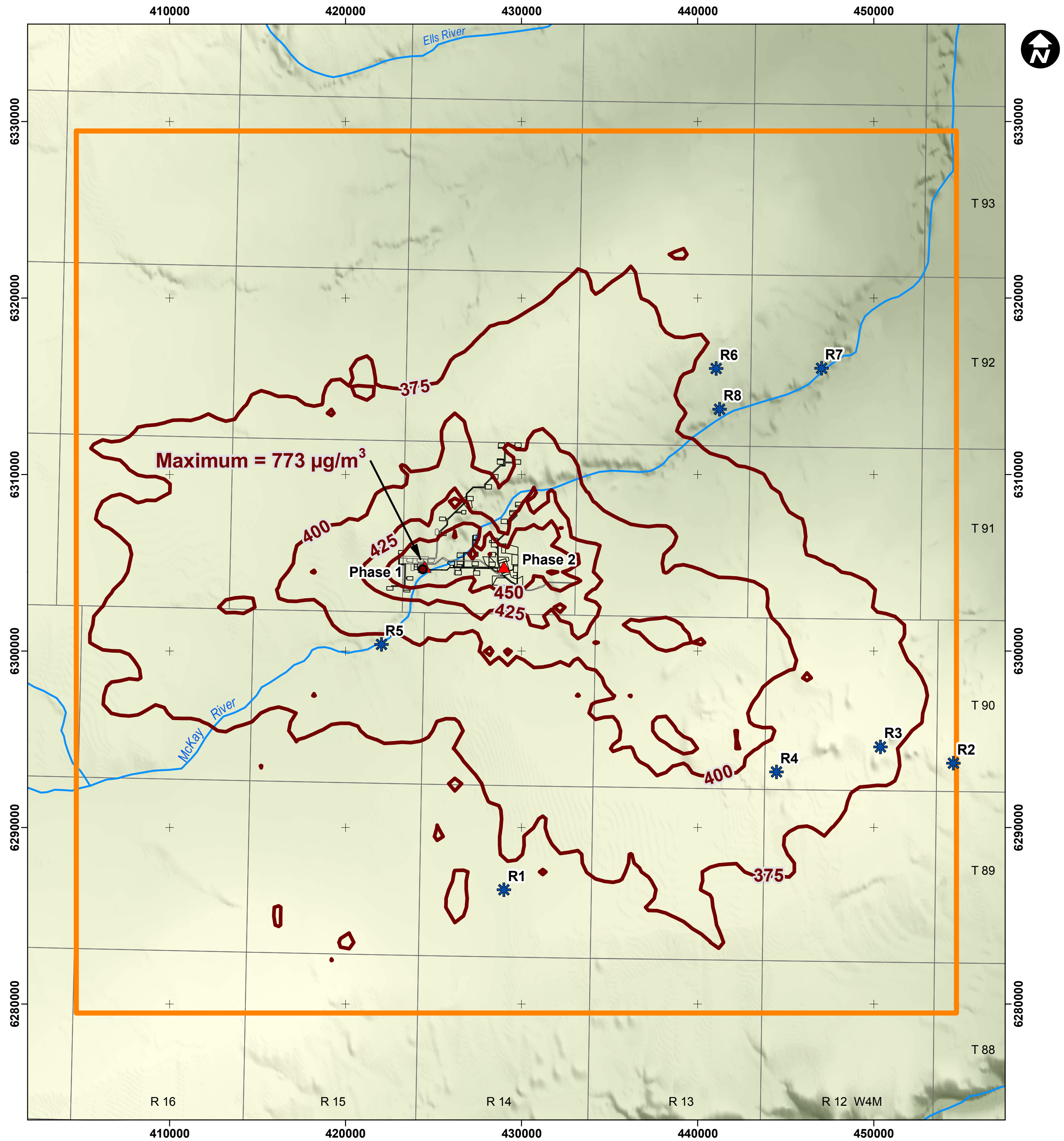
CHECKED: EL

DATE: Oct 22/12

PROJECT: 10-037

FIGURE: 4.6

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel\Fig 4.6 Annual NO2.mxd) 10/22/2012 -- 1:18:28 PM



0 2.5 5 10
Kilometres

Legend

- AQ Local Study Area
- Approved Phase 1 Development
- Proposed Initial Phase 2 Development
- Isopleth Concentration

Topography (masl)
High : 800
Low : 200

Receptors	
R1	Kelley McNeilly Cabin
R2	Damon and Sharon Wright
R3	Pliska Cabin A
R4	Pliska Cabin B
R5	Pliska Cabin C
R6	Powder Cabin A
R7	MacDonald Cabin B
R8	Powder Cabin B

SOUTHERN PACIFIC RESOURCE CORP.

STP McKay Thermal Project - Phase 2

Millennium EMS Solutions Ltd.

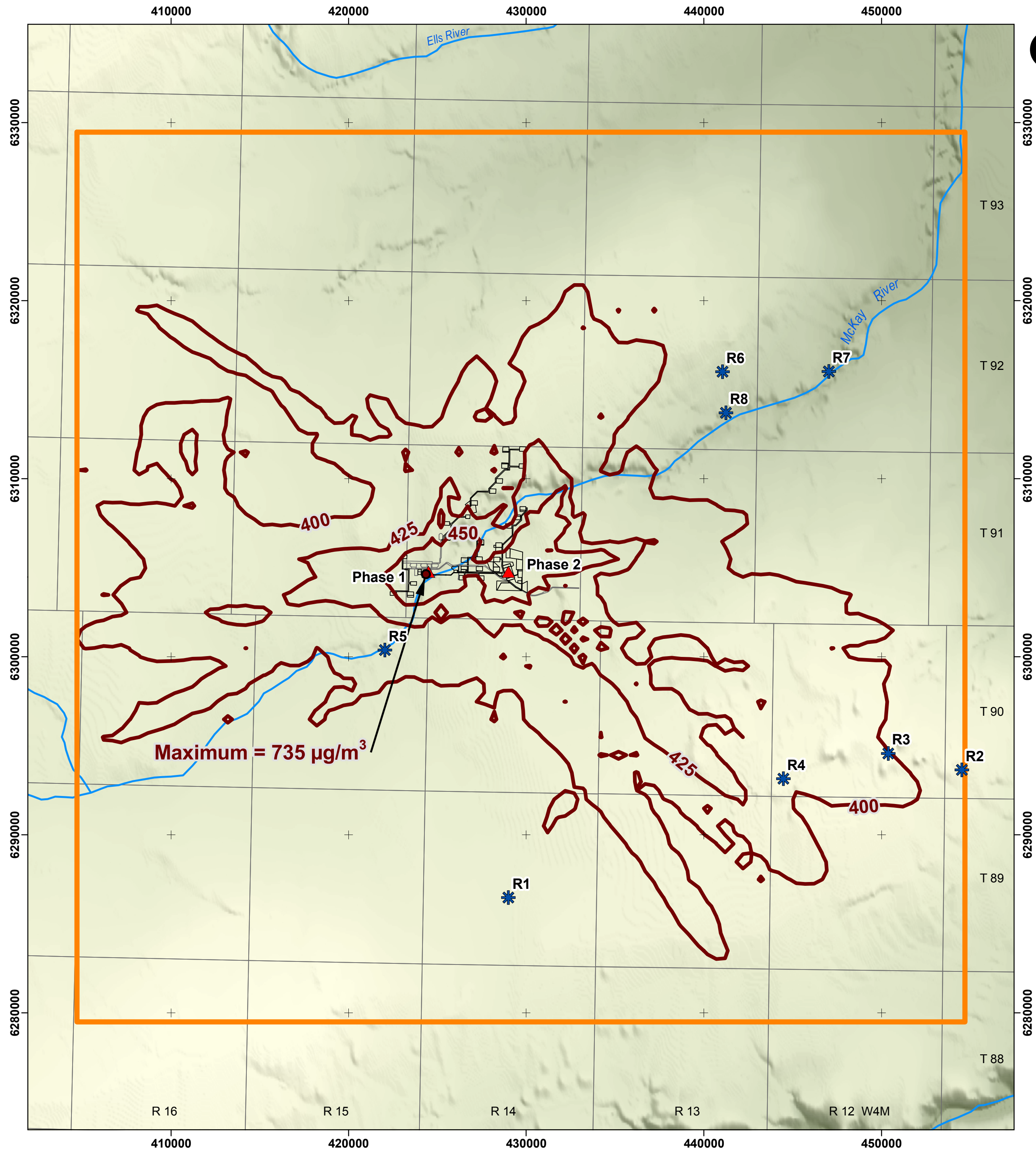
TITLE:

Predicted 9th Highest Hourly CO Concentration (µg/m³) - Project Case

DRAWN: JG
CHECKED: EL
DATE: Oct 22/12
PROJECT: 10-037

FIGURE: 4.7

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel\Fig 4.7 Hourly CO.mxd) 10/22/2012 -- 1:19:47 PM



0 2.5 5 10
Kilometres

Legend

- AQ Local Study Area
- Approved Phase 1 Development
- Proposed Initial Phase 2 Development
- Isopleth Concentration

Topography (masl)
High : 800
Low : 200

Receptors	
R1	Kelley McNeilly Cabin
R2	Damon and Sharon Wright
R3	Pliska Cabin A
R4	Pliska Cabin B
R5	Pliska Cabin C
R6	Powder Cabin A
R7	MacDonald Cabin B
R8	Powder Cabin B

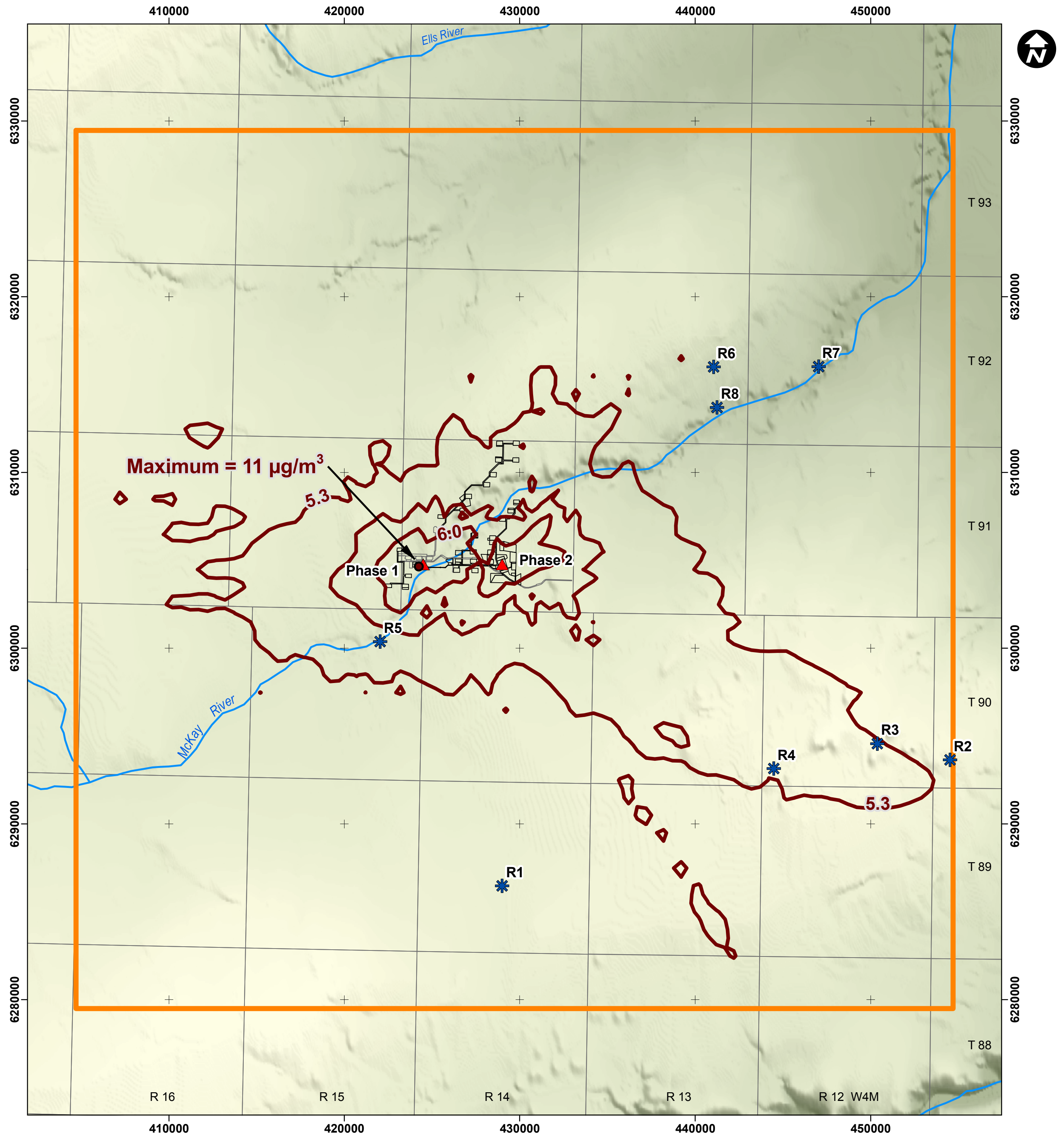
SOUTHERN PACIFIC RESOURCE CORP.

STP McKay Thermal Project - Phase 2

Millennium EMS Solutions Ltd.

TITLE:
Predicted Maximum 8-hour CO Concentration (µg/m³) - Project Case

DRAWN: JG
CHECKED: EL
DATE: Oct 22/12
PROJECT: 10-037
FIGURE: 4.8



0 2.5 5 10
Kilometres

Legend

- AQ Local Study Area
- Approved Phase 1 Development
- Proposed Initial Phase 2 Development
- Isopleth Concentration

Topography (masl)

High : 800

Low : 200

Receptors	
R1	Kelley McNeilly Cabin
R2	Damon and Sharon Wright
R3	Pliska Cabin A
R4	Pliska Cabin B
R5	Pliska Cabin C
R6	Powder Cabin A
R7	MacDonald Cabin B
R8	Powder Cabin B

SOUTHERN PACIFIC RESOURCE CORP.

STP McKay Thermal Project - Phase 2

Millennium EMS Solutions Ltd.

TITLE:

Predicted 2nd Highest Daily PM2.5 Concentration (µg/m³) - Project Case

DRAWN: JG

CHECKED: EL

DATE: Oct 22/12

PROJECT: 10-037

FIGURE: 4.9

Map Document: (K:\Active Projects 2010\AP 10-001 to 10-050\10-037 STP McKay\Final Docs\Air Quality\Remodel\Fig 4.9 Daily PM2.5.mxd) 10/22/2012 -- 1:22:44 PM